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GARDENS' BULLETIN

STRAITS SETTLEMENTS

Vol. IX 20th December, 1935 Part 1

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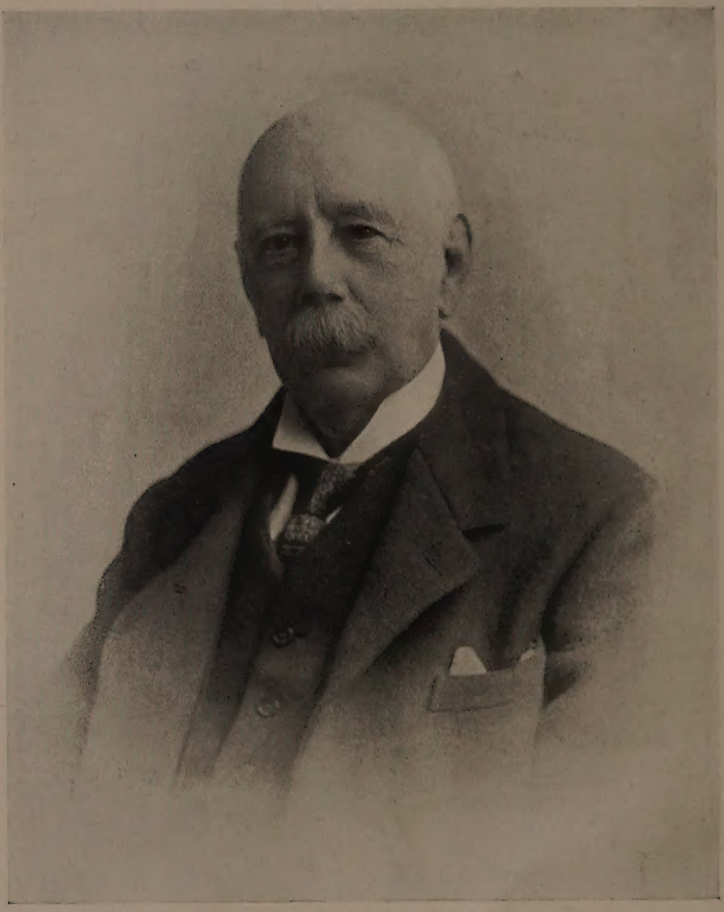

H. N. Ridley, C. M. G., F. R. S.

THE

GARDENS' BULLETIN

STRAITS SETTLEMENTS

Vol. IX 20th December, 1935. Part 1

This Bulletin is dedicated to

HENRY NICHOLAS RIDLEY, C.M.G., M.A., F.R.S.

Director of Gardens, Straits Settlements, 1888–1911
on the occasion of his 80th birthday

Mr. Ridley's work as a field botanist added more than that of any other single man to our knowledge of the flora of the Malay Peninsula; his *Flora* is the foundation upon which all future work must rest; he actively pursued the experimental cultivation of agricultural plants at a time when agricultural interests in Malaya were at a low ebb; in particular, his persistent advocacy of the plantation of Para Rubber and his pioneer tapping experiments were largely responsible for the foundation of that industry upon which so large a share of the wealth of Malaya has rested; his reports on timbers, rattans, and other forest products of the Peninsula were the first adequate works of their kind and embodied much original information; he added very considerably to the collection of cultivated plants, both Malayan and exotic, in the Botanic Gardens, Singapore; his wide interests, not only in botany but also in entomology, geology and other branches of natural science, found expression in a series of papers which are enumerated in the bibliography which follows. Few men have accomplished so much in 23 years of tropical service, and few have been able to complete their work after retirement as Mr. Ridley has completed it.

The contributors to this Bulletin, and many more who have followed in the paths where Mr. Ridley led, unite in congratulating him on the present happy occasion.

BIBLIOGRAPHY OF THE WORKS OF MR. H. N. RIDLEY, FROM 1872 TO 1935,

compiled by

M. R. HENDERSON and C. G. G. J. VAN STEENIS

This bibliography has been made as complete as possible, but as Mr. Ridley has published, over a long period, a very large amount of material covering a very wide field of pure and applied botany, the compilers realise that a number of papers may have been overlooked.

During 63 years of activity Mr. Ridley has published, according to this bibliography, more than 500 books, papers and notes, amounting to nearly 10,000 printed pages.

Amongst the more important works may be mentioned his various papers on Monocotyledons, on which he was a well known authority; and his various articles on plant dispersal, resulting in his monumental "Dispersal of Plants throughout the World", published when he was 75, an age at which most authors are content to enjoy a well earned rest. His life-work, however, has been devoted to Malaysian botany, to the knowledge of which he has contributed largely, both as a writer and as a keen collector.

1872

Mammals and Coleoptera of Haileybury (School Nat. Hist. Report, 1872).

1875

Sphinx convolvuli at Cobham, Kent (Entomologist, 1875, p. 223).

1876

Hibernation of Hemerobius (Entomologist, 1876, p. 48).

1878

Coleoptera hunting in 1877 (Entomologist, 1878, p. 22).

Acronycta Alni in Hereford (Entomologist, 1878, p. 230).

1879

Doridicola antheæ, n. sp. (Copepoda) (Ann. Mag. Nat. Hist. 4, 1879, p. 458).

1880

Spring flowering form of Colchicum autumnale (Journ. Bot. 18, 1880, p. 185).

Observations on some Larvæ of Chrysopa (Entomologist, 13, 1880, p. 21).

Some English Collembola (Entomologists' Monthly Magazine, 17, 1880, p. 1).

1881

A new variety of Carex pilulifera L. (Journ. Bot. 19. 1881, p. 97–98, 152, t. 218).

Notes on Radnorshire plants (Journ. Bot. 19, 1881, p. 170–174).

Degeeria Eatoni, n. sp. (Entomologists' Monthly Magazine, 17, 1881, p. 270).

Thysanura of Canary Isles (Entomologists' Monthly Magazine, 18, 1881, p. 14).

1882

(With FAWCETT) Additions to the flora of Dorset (Journ. Bot. 20, 1882, p. 246).

1883

Teratological notes on plants I. (Journ. Linn. Soc. London, Bot. 20, 1883, p. 45–48, 3 figs., read 1882).

Descriptions and notes on new or rare monocotyledonous plants from Madagascar, with one from Angola (Journ. Linn. Soc. London, Bot. 20, 1883, p. 329–338).

On the generic names Dantia and Prouvenzalia (Journ. Bot. 21, 1883, p. 349).

1884

The Cyperaceae of the West Coast of Africa in the Welwitsch Herbarium (Transact. Linn. Soc. London, Bot. 2nd ser., vol. 2, 1884, p. 121–172, pl. 22–23).

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Bees and Erica cinerea (Journ. Bot. 22, 1884, p. 302).

A new Bornean Orchid (Journ. Bot. 22, 1884, p. 333).

On Didymoplexis sylvatica (Leucorchis sylvatica Blume) (Journ. Bot. 22, 1884, p. 345–346).

A new species of Albuca from Aden (Journ. Bot. 22, 1884, p. 370).

Additions to "Topographical Botany" (Journ. Bot. 22, 1884, p. 377–378).

1885

The Orchids of Madagascar (Journ. Linn. Soc. London, Bot. 21, 1885, p. 456–522, pl. 15).

Prodromus floræ timorensis; compiled by the Botanical Department of the British Museum, Monocotyledones (in H. O. FORBES, A Naturalist's Wanderings, etc. 1885, p. 518–523).

On Juncus tenuis as a British plant (Journ. Bot. 23, 1885, p. 1–3, t. 253).

A new Carex from Sumatra (Journ. Bot. 23, 1885, p. 35–36).

A new Dendrobium from Siam (Journ. Bot. 23, 1885, p. 123).

A new Habenaria from Brazil (Journ. Bot. 23, 1885, p. 170).

Crocus Korolokawi in Afghanistan (Journ. Bot. 23, 1885, p. 185).

Peloria in Habenaria bifolia Br. (Journ Bot. 23, 1885, p. 218–219).

Castanea sativa Mill. as a native of Britain (Journ. Bot. 23, 1885, p. 253–254).

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Angroecum glomeratum, n. sp. (Gardeners Chronicle, 24, 1885, p. 678).

1886

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On Dr. Fox's collection of orchids from Madagascar, along with some obtained by the Rev. R. Baron, F.L.S. from the same island (Journ. Linn Soc. London, Bot. 22, 1886, p. 116–127).

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Habenaria albida in Brecon (Journ. Bot. 24, 1886, p. 285).

A new Amorphophallus from Gambia (Journ. Bot. 24, 1886, p. 305–306).

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1887

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1889

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1890

Notes on the Botany of Fernando de Noronha (Journ. Linn. Soc. London, Bot. 26, 1890, p. 1–74, pl. 1–4)

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On the method of fertilisation in Bulbophyllum macranthum and allied Orchids (Ann. Bot. 4, 1890, p. 327–356, pl. 22A).

On the habits of the Caringa (Formica gracilipes Gray) (Journ. Str. Br. Roy. As. Soc. 22, 1890, p. 345–347).

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1892

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1897

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1898

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1901

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1902

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Aristolochia minutiflora Ridley ms. (Kew Bull. 1910, p. 79).

Poisonous principles of Rhus (Pharmaceutical Journal, March 19, 1910, p. 360).

1911

Legislation against the dissemination of Pests (Agric. Bull. S.S. & F.M.S. 10, no. 1, 1911, p. 1–4).

Eutypa as a Parasite (Agric. Bull. S.S. & F.M.S. 10, no. 1, 1911, p. 6).

Gum Benjamin (Agric. Bull. S.S. & F.M.S. 10, no. 1, 1911, p. 12–16).

Rubber Smoking House (Agric. Bull. S.S. & F.M.S. 10, no. 3, 1911, p. 64–66).

Science and Agriculture (Agric. Bull. S.S. & F.M.S. 10, no. 3, 1911, p. 66–68).

Hevea disease in Ceylon (Agric. Bull. S.S. & F.M.S. 10, no. 3, 1911, p. 70–71).

Mustard as a Catchcrop for Rubber (Agric. Bull. S.S. & F.M.S. 10, no. 3, 1911, p. 74).

Spangle-scale on Soursop (Agric. Bull. S.S. & F.M.S. 10, no. 3, 1911, p. 74–75).

Chonemorpha rubber vines (orig. descript. of Ch. Rheedei and Ch. penangensis) (Agric. Bull. S.S. & F.M.S. 10, no. 5, 1911, p. 146–148).

Fasciation in Eucharis (Agric. Bull. S.S. & F.M.S.. 10, no. 5, 1911, p. 154).

The Drought spell (Agric. Bull. S.S. & F.M.S. 10, no. 6, 1911, p. 181–186).

Travelling of Rubber seed (Agric. Bull. S.S. & F.M.S. 10, no. 6, 1911, p. 191–192).

Stumping on Estates (Agric. Bull. S.S. & F.M.S. 10, no. 6, 1911, p. 195).

Birds and Crops (Agric. Bull. S.S. & F.M.S. 10, no. 8, 1911, p. 232–235).

Cinnamomum Deschampsii (Agric. Bull. S.S. & F.M.S. 10, no. 8, 1911, p. 235).

Abnormal Rubber tree (Agric. Bull. S.S. & F.M.S. 10, no. 11, 1911, 351–352).

Root-shoots in Casuarina glauca (Agric. Bull. S.S. & F.M.S. 10, no. 11, 1911, p. 359).

A Bleeding Rubber tree (Agric. Bull. S.S. & F.M.S. 10, no. 11, 1911, p. 361).

The Flora of Lower Siam (Journ. Str. Br. Roy. As. Soc. 59, 1911, p. 15–26).

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An Account of a Botanical Excursion to Lower Siam (Journ. Str. Br. Roy. As. Soc. 59, 1911, p. 27–234, map.).

The Rt. Rev. M. F. Hose, D.D. (Journ. Str. Br. Roy. As. Soc. 57, 1911, p. 3–4).

A scientific expedition to Temengoh, Upper Perak (Journ. Str. Br. Roy. As. Soc. 57, 1911, p. 5–122).

Rengas Poisoning (Malayan Medical Journal, 9, 1911, p. 7–13).

A retrospect and some cautions (Grenier's Rubber News, Kuala Lumpur, 1911).

1912

A botanical excursion to Pulau Adang (Journ. Str. Br. Roy. As. Soc. 61, 1912, 45–65).

New plants from Sarawak (Sarawak Mus. Journ. 12, 1912, p. 30–38).

Spices (1912, Macmillan & Co., London, viii + 449 pp.).

New or rare Malayan plants (series VI) (Journ. Str. Br. Roy. As. Soc. 61, 1912, p. 1–43).

Some plants collected on Moulton's Expedition to Batu Lawi (Journ. Str. Br. Roy. As. Soc. 63, 1912, p. 59–62).

Decades Kewenses (Kew Bull. 1912, p. 380–389).

1913

Contributions to a flora of Borneo (Sarawak Mus. Journ. 13, 1913, p. 67–98).

Some Bornean Aroideæ (Journ. Bot. 51, 1913, p. 201–202, t. 527).

An expedition to Mount Mĕnuang Gasing, Selangor; with an account of the journey by C. B. Kloss (Journ. Linn. Soc. Bot. 41, 1913, p. 285–304).

A new Alpinia from Borneo (Journ. Bot. 51, 1913, p. 247).

Decades Kewenses (Kew Bull. 1913, p. 267–268).

African Zingiberaceæ (in Talbot's South Nigerian Plants, Brit. Mus. Public., 1913, p. 110–112).

1914

On a collection of plants from G. Mengkuang Lebah, Selangor (Journ. Fed. Mal. St. Mus. 5, 1914, p. 28–50).

Plantæ novæ papuanæ (Journ. Bot. 52, 1914, p. 289–296).

Decades Kewenses (Kew Bull. 1914, p. 188, 209–210, 211, 324, 327, 332, 377–378).

Moraceæ, Scitamineæ, Hæmodoraceæ, Iridaceæ, Amaryllidaceæ, Taccaceæ, Dioscoreaceæ, Liliaceæ, Pontederiaceæ, Xyridaceæ, Commelinaceæ, Araceæ, Eriocaulaceæ, in L. S. Gibbs Contribution Flora, etc. of Mt. Kinabalu (Journ. Linn. Soc. London Bot. 42, 1914, p. 136–138, 162–167, 171–172).

Cypripedium Pereiræ, n. sp. (Gardeners Chronicle, 55, 1914, p. 236).

1915

On two new plants from Gunong Tampin, Negri Sembilan (Journ. Fed. Mal. Stat. Mus. 6, pt. 1, 1915, p. 39).

A new Begonia from Borneo (Sarawak Mus. Journ. 26, 1915, p. 177).

An expedition to Mt. Menuang Gasing, Selangor (Journ. Fed. Mal. Stat. Mus. 6, 1915, p. 1–21).

Plants from G. Kerbau, Perak (Journ. Fed. Mal. Stat. Mus. 6, 1915, p. 43–62).

New or rare Malayan plants series VII (Journ. Str. Br. Roy. As. Soc. 68, 1915, p. 11–14).

Two new orchids from the Prov. of Bandon, S.W. Siam (Journ. Fed. Mal. Stat. Mus. 5, 1915, p. 156–157).

The plants of Koh Samui and Koh Pennan (Journ. Fed. Mal. Stat. Mus. 5, 1915, p. 158–168).

The botany of G. Tahan (Journ. Fed. Mal Stat. Mus. 6, 1915, p. 127–202).

Cytinaceæ and Balanophoraceæ in Gamble, Materials for a flora of the Malay Peninsula (Journ. As. Soc. Bengal 75, pt. 4, 1915, p. 393–399).

1916

Drimys elongata Ridl. (Hooker, Icon. Plant. 31, 1916, t. 3051).

Aglaia rubra Ridl. (Hook. Icon. Plant. 31, 1916, t. 3052).

Timonius vaccinioides Wernh. (Hook. Icon. Plant. 31, 1916, t. 3054).

Vittadinia disticha S. Moore (Hook. Icon. Plant. 31, 1916, t. 3055).

Mischopleura Ridleyana Wernh. and M. ovalifolia Wernh. (Hook. Icon. Plant. 31, 1916, t. 3059).

Neowollastonia tabernæmontanoides Wernh. (Hook. Icon. Plant. 31, 1916, t. 3060).

Solanum peranomalum Wernh. (Hook Icon. Plant . 31, 1916, t. 3062).

Eriolopha flagellaris Ridl. (Hook. Icon. Plant. 31, 1916, t. 3067).

New or rare Malayan plants series VIII (Journ. Str. Br. Roy. As. Soc. 73, 1916, p. 139–146).

On endemism and the mutation theory (Ann. Bot. 30, 1916, p. 551–574).

Report on the Botany of the Wollaston Expedition to Dutch New Guinea 1912–1913 (Trans.Linn. Soc. London Bot. ser. 2, 9, 1916, p. 1–269).

The natural history of Kedah Peak V. Botany (Journ. Fed. Mal. Stat. Mus. 7, 1916, p. 37–58).

The large Mias in the Zoological Gardens (Field, July, 1916).

Cultivation of Rubber in Malaya and Burma (Times Supplement, 1916).

1917

New or rare Malayan plants series IX (Journ. Str. Br. Roy As. Soc. 75, 1917, p. 5–38).

The scientific exploration of the Malay Peninsula (Journ. Str. Br. Roy. As. Soc. 75, 1917, p. VII–XI).

Botany of Kedah Peak (Journ. Fed Mal. Stat. Mus. 7, 1917, p. 12).

Lasianthus barbellatus, a new species from P. Tiuman (Journ. Str. Br. Roy. As. Soc. 77, 1917, p. 187, 1 fig.).

Results of an expedition to Korinchi Peak, Sumatra (Journ. Fed. Mal. Stat. Mus. 8, part 4, 1917, p. 9–145).

Moraceæ in L. S. Gibbs, Contribution to the Flora and Phytography of the Arfak Mts., etc. 1917, p. 208–209.

1918

New or rare Malayan plants series X (Journ. Str. Br. Roy. As. Soc. 79, 1918, p. 63–100).

Hoseanthus Merr. nov. gen. (Journ. Str. Br. Roy. As. Soc. 79, 1918, p. 17).

Appendix II to Gibbs, Some peculiar Papuan customs (Journ. Str. Br. Roy. As. Soc. 79, 1918, p. 16).

1919

The fern-allies and Characeæ of the Malay Peninsula (Journ. Str. Br. Roy. As. Soc. 80, 1919, p. 139–164).

Cultivated Arundinas (Orchid Review, 27, 1919, p. 46).

1920

New Malayan plants (Journ. Bot. 58, 1920, p. 147–149, 195–196).

New or rare plants from the Malay Peninsula (Journ. Fed. Mal. Stat. Mus. 102, 1920, p. 128–156).

New or rare species of Malayan plants (Journ. Str. Br. Roy. As. Soc. 82, 1920, p. 167–204).

On a collection of plants from Peninsula Siam (Journ. Fed. Mal. Stat. Mus. 10, 1920, p. 65–126).

Two new Siamese plants (Journ. Fed. Mal. Stat. Mus. 10, 1920, p. 127).

Plantago Cynops L. in Kent (Journ. Bot. 58, 1920, p. 127–272).

1921

The Indo-Malayan species of Jussieua (Journ. Bot. 59, 1921, p. 257–260).

Plant dermatitis (Journ. Bot. 1921, p. 310).

Plants from Annam, Scitamineæ and Orchideæ (Journ. Nat. Hist. Siam, 4, 1921, p. 109).

1922

The Flora of the Malay Peninsula, Vol. I (Reeve & Co., London, 1922, p. xxxv+918).

Rigiolepis and other Vacciniaceæ of Borneo (Kew Bull. 1922, p. 106–108).

The Flora of Klang Gates, Selangor (Journ. Fed. Mal. Stat. Mus. 10, 1922, p. 247–251).

New or rare Malayan plants series XII (Journ. Str. Br. Roy. As. Soc. 86, 1922, p. 292–311).

Sandoricum Koetjape and Dendrobium caninum (Journ. Bot. 60, 1922, p. 273–274).

Plant Dermatitis (Journ. Trop. Med. & Hyg. 25, no. 14, 1922, p. 225–227).

Musaceæ, Zingiberaceæ and Marantaceæ in C. T. WHITE, A contribution to our knowledge of the Flora of Papua (British New Guinea) (Proc. Roy. Soc. Queensl. XXXIV, no. 1, 1922, p. 19–22).

Note on clearing ponds with Copper Sulphate (Field, May, 1922).

1923

New Euphorbiaceæ from the Malay Peninsula (Kew Bull. 1923, p. 360–369).

The Flora of the Malay Peninsula Vol. 2 (Reeve & Co., London, 1923 p. vi+672, fig. 76–131).

A Botanical Excursion in Northern Sumatra (Journ. Mal. Br. Roy. As. Soc. 87, 1923, p. 46–113).

The distribution of plants (Ann. Bot. 37. 37, 1923, p. 1–29).

Koetjape and sentol (Journ. Bot. 61, 1923, p. 200–201).

Vanda punctata Ridley (Kew Bull. 1923, p. 118).

1924

The Flora of the Malay Peninsula vol. 3 (Reeve & Co., London, 1924, p. vi+406, fig. 1–159).

New Malayan plants (Journ. Bot. 62, 1924, p. 294–301).

The Flora of the Malay Peninsula, Vol. 4 (Reeve & Co., London, 383 pp., fig. 169–209).

Lotus siliquosus L. in Berks (Journ. Bot. 62, 1924, p. 246).

Decades Kewenses (Kew Bull. 1924, p. 202, 204, 261–262, 263, 266).

Poisoning by Bamboo Hairs (Journ. Trop. Med. & Hyg. 27, 1924, p. 278).

Evodia quercifolia, n. sp. (Gardeners Chronicle, 76, 1924, p. 303).

1925

The Flora of the Malay Peninsula vol. 5 (Reeve & Co., London, 470 pp., fig. 210–229).

Plants of Bencoolen collected by Mr. C. J. Brooks (Kew Bull. 1925, p. 76–94).

New Diospyros from Sarawak (Journ. Bot. 63, 1925, p. 51–52).

Endemic plants (Journ. Bot. 63, 1925, p. 182–183).

Dr. H. O. Forbes' Malayan plants. Monocotyledones (Journ. Bot. 63, 1925, Suppl. p. 115–127).

Globba Burbidgei Ridley n. sp. (Journ. Bot. 63, 1925, p. 204).

Decades Kewenses (Kew Bull. 1925, p. 280–281).

Use of Iodine in Beri-beri (Journ. Trop. Med. & Hyg. 28, 1925, p. 102–103).

1926

Spolia Mentawiensia (Kew Bull. 1926, p. 57–94).

The ferns of the Malay Peninsula (Journ. Mal. Br. Roy. As. Soc. 4, 1926, p. 1–121).

Additions to the flora of Malaya (Kew Bull. 1926, p. 469–479).

Cause of hairlessness in Man (Journ. Trop. Hygiene, Sept. 15, 1926, p. 303).

White Blackbird in Kew Gardens (Country Life, Jan. 1926).

Habits of Pangolin (Country Life, Jan. 1926).

1927

The genus Argostemma (Journ. Bot. 65, 1927, p. 25–41).

A correction.—Sonerila ciliata (Journ. Bot. 65, 1927, p. 184).

Rev. W. A. Taylor, M.A. Obituary (Journ. Bot. 65, 1927, p. 317).

Voices of Apes (London Illustrated News, Sept. 17, 1927).

Letter on Rubber Industry (Journal of Heredity, 9, 1927, p. 485).

1928

Cotyledon Umbilicus as an epiphyte (Journ. Bot. 66, 1928, p. 273).

Charles Curtis. Obituary (Journ. Bot. 66, 1928, p. 332–333).

Decades Kewenses (Kew Bull. 1928, p. 72–78).

History of the evolution of the cultivated Rubber industry (Bull. Rubber Growers' Ass. 1928, p. 3–7).

1929

New species from the Malay Peninsula and Borneo (Kew Bull. 1929, p.254–262).

Schefflera minimiflora Ridl. comb. nov. (Journ. Bot. 67, 1929, p. 87).

H. C. Robinson. Obituary (Journ. Bot. 67, 1929, p. 261).

Elephant Cemeteries (Times, London, August 5, 1929).

1930

Additions to the flora of Borneo and other Malay Islands (Kew Bull. 1929, p. 364–373).

The Dispersal of Plants throughout the World. (Reeve & Co., Kent, 1930, xx+744 pp., 22 pl).

Myrtaceæ malayenses (Journ. Bot. 68, 1930, p. 10–17, 33–39).

Asiatic species of Pleomele (Journ. Bot. 68, 1930, p. 177–181).

Additions to the flora of Borneo (Kew Bull. 1930, p. 74–87).

On the action of the poison of the Upas tree (*Antiaris toxicaria* Bl.) (Journ. Trop. Med. & Hyg. July, 1930, p.1–2).

1931

Additions to the flora of Borneo and other Malay Islands II (Kew Bull. 1931, p. 33–39).

Additions to the flora of Borneo and other Malay Islands III (Kew Bull. 1931, p. 493–499).

Decades Kewenses LX (Kew Bull. 1931, p. 448–449).

How Plants move about (The Listener, May 20, 1931).

1932

Taraktogenos calophylla Ridley (Hook. Icon. Plant. 32, 1932, t. 3167).

Sonerila Ruttneri n. sp., Didissandra parviflora n. sp. (Arch. f. Hydrobiol. Suppl. Bd. 11, 1932, p. 312–313, 327–328).

The genus Urophyllum in Malaya (Journ. Bot. 70. 70, 1932, p. 191–197, 219–226).

Sir Everard Ferdinand im Thurm. Obituary (Journ. Bot. 70, 1932, p. 341–342).

Poisonous Nature of *Derris elliptica* (Pharmaceutical Journal, 129, 1932, p. 387).

1933

G. Ramage. Obituary (Journ. Bot. 71, 1933, p. 75).

Rocks grooved by Ficus roots (Journ. Bot. 71, 1933, p. 75–76).

Additions to the flora of Borneo and other Malay Islands IV (Kew Bull. 1933, p. 190–202).

Contributions towards a flora of British North Borneo III (Kew Bull. 1933, p. 487–495).

Fruiting of Passion-flower (*Passiflora*) in England (Times, London, March 10, 1933).

1934

Firmiana and Erythropsis (Kew Bull. 1934, p. 214–217).

Some dispersal notes (Journ. Bot. 72, 1934, p. 52–53).

J. D. Gimlette. Obituary (Journ. Bot. 72, 1934, p. 176).

New Malayan Rubiaceæ (Journ. Bot. 72, 1934, p. 251–257, 271–275).

Dorycnium gracile in Kent (Journ. Bot. 72, 1934, p. 349–350).

Review of Beccari's Asiatic Palms, Corypheæ (Nature, 133, 1934, p. 122).

Notes on insects special protection (Proc. Roy. Soc. London, 7, 1934, p. 634).

1935

Malay violets (Journ. Bot. 73, 1935, p. 13–18).

LIST OF PLANTS NAMED IN HONOUR OF MR. H. N. RIDLEY.

GENERA.

RIDLEYELLA, Schlechter (Orchidaceae).

RIDLEYINDA, Kuntze (Dipterocarpaceae).

SPECIES.

Malay Peninsula:—

Acriopsis Ridleyi, Hook. f. (Orchidaceae).
Acroceras Ridleyi, Stapf (Gramineae).
Actinodaphne Ridleyi, Gamble (Lauraceae).
Actoplanes Ridleyi, Schum. (Zingiberaceae).
Alangium Ridleyi King (Cornaceae).
Alseodaphne Ridleyi, Gamble (Lauraceae).
Amoora Ridleyi, King (Meliaceae).
Ardisia Ridleyi, King & Gamble (Myrsinaceae).
Argostemma Ridleyi, King (Rubiaceae).
Bauhinia Ridleyi Prain (Leguminosae).
Bambusa Ridleyi, Gamble (Gramineae).
Calamus Ridleyanus, Beccari (Palmae).
Castanopsis Ridleyi, Gamble (Cupuliferae).
Cephaelis Ridleyi, King & Gamble (Rubiaceae).
Cinnamomum Ridleyi, Gamble (Lauraceae).
Clerodendron Ridleyi, King & Gamble (Verbenaceae).
Diospyros Ridleyi, Bakh. (Ebenaceae).
Embelia Ridleyi, King & Gamble (Myrsinaceae).
Endopogon Ridleyi, Clarke (Acanthaceae).
Epigynum Ridleyi, King & Gamble (Apocynaceae).
Eria Ridleyi, Rolfe (Orchidaceae).
Eugenia Ridleyi, King (Myrtaceae).
Eulalia Ridleyi, Stapf (Gramineae).
Fagraea Ridleyi, King & Gamble (Loganiaceae).
Filetia Ridleyi, Clarke (Acanthaceae).
Galearia Ridleyi, Gage (Euphorbiaceae).
Genianthus Ridleyi, King & Gamble (Asclepiadaceae).
Goniothalamus Ridleyi, King (Anonaceae).
Gnetum Ridleyi, Gamble (Gnetaceae).
Gymnostachyum Ridleyi, Clarke (Acanthaceae).
Hemigraphis Ridleyi, Clarke (Acanthaceae).
Henslowia Ridleyi, Gamble (Santalaceae).
Homalomena Ridleyana, Engl. (Araceae).
Horsfieldia Ridleyana, Warb. (Myristicaceae).
Hoya Ridleyi, King & Gamble (Asclepiadaceae).
Impatiens Ridleyi, Hook. f. (Balsaminaceae).
Kopsia Ridleyana, King & Gamble (Apocynaceae).
Kunstleria Ridleyi, Prain (Leguminosae).
Lasianthus Ridleyi, King & Gamble (Rubiaceae).
Lecanorchis Ridleyana, Schl. (Orchidaceae).
Lettsomia Ridleyi, Prain (Convolvulaceae).
Litsea Ridleyi, Gamble (Lauraceae).
Lucinaea Ridleyi, King & Gamble (Rubiaceae).
Meliosma Ridleyi, King (Sabiaceae).
Morinda Ridleyi, King & Gamble (Rubiaceae).

Ochlandra Ridleyi, Gamble (Gramineae).
Oryza Ridleyi, Hook. f. (Gramineae).
Pachynocarpus Ridleyanus, Brandis (Dipterocarpaceae).
Palaquium Ridleyi, King & Gamble (Sapotaceae).
Pandanus Ridleyi, Martelli (Pandanaceae).
Pentaphragma Ridleyi, King & Gamble (Campanulaceae).
Piper Ridleyi, C. DC. (Piperaceae).
Piptospatha Ridleyi, Hook. f. (Araceae).
Polyosma Ridleyi, King (Saxifragaceae).
Premna Ridleyi, King & Gamble (Verbenaceae).
Psychotria Ridleyi, King & Gamble (Rubiaceae).
Saprosma Ridleyi, King & Gamble (Rubiaceae).
Schefflera Ridleyi, Viguier (Araliaceae).
Schismatoglottis Ridleyana, Engl. (Araceae).
Scleria Ridleyi, Clarke (Cyperaceae).
Scleropyrum Ridleyi, Gamble (Santalaceae).
Sclerostachyum Ridleyi, Stapf (Gramineae).
Shorea Ridleyana, King (Dipterocarpaceae).
Spatholobus Ridleyi, Prain (Leguminosae).
Stenothyrsus Ridleyi, Clarke (Acanthaceae).
Strychnos Ridleyi, King & Gamble (Loganiaceae).
Styrax Ridleyanum, Perkins (Styraceae).
Symplocos Ridleyi, King & Gamble (Symplocaceae).
Tarenna Ridleyi, Pearson (Rubiaceae).
Tylophora Ridleyi, Henders. (Asclepiadaceae).
Uvaria Ridleyi, King (Anonaceae).
Wikstoemia Ridleyi, Gamble (Thymeleaceae).
Xylopia Ridleyi, King (Anonaceae).
Xyris Ridleyi, Rendle (Xyridaceae).

Ferns:—

Alsophila Ridleyi, Baker.
Athyrium Ridleyi, Copeland.
Lastrea Ridleyi, Beddome.
Microlepia Ridleyi, Copeland.
Platycerium Ridleyi, Christ.
Trichomanes Ridleyi, Copeland.

Borneo:—

Coelogyne Ridleyana, Schltr. (Orchidaceae).
Dendrobium Ridleyi, Merr. (Orchidaceae).
Dioscorea Ridleyi, Prain & Burkill (Dioscoreaceae).
Panicum Ridleyi, Hack. (Gramineae).
Pollinia Ridleyi, Hack. (Gramineae).
Raphidophora Ridleyi, Merr. (Araceae).
Sarcanthus Ridleyi, J. J. Smith (Orchidaceae).
Saurauia Ridleyi, Merr. (Ternstroemiaceae).
Thoracostachyum Ridleyi, Clarke (Gramineae).

Siam:—

Dendrobium Ridleyanum, Kerr (Orchidaceae).
Hedyotis Ridleyana, Craib (Rubiaceae).
Ophiorrhiza Ridleyana, Craib (Rubiaceae).

Mr RIDLEY and his collector ACHMAD BIN HASSAN in the Gardens Jungle, about 1909.

MR. RIDLEY'S WORK FOR TROPICAL AGRICULTURE.

By F. W. South,
Chief Field Officer, Department of Agriculture S.S. & F.M.S.

Introduction.

Mr. H. N. Ridley, C.M.G., F.R.S., was Director of Gardens, Straits Settlements from 1888 to 1911 and for the period 1888 to 1894 was also Director of Forests, Straits Settlements. Probably but few people at the present time realise how great a debt Malaya as a whole owes to Ridley for his services in laying a sure foundation for that agricultural development which subsequently brought so much prosperity to this country.

The work which Ridley did during his period of service in Malaya was only rendered possible by his tireless energy and enthusiasm and his wide knowledge of biology, including both botany and zoology. He specialised more particularly in botany, including in that term pure botany as a sience and botany as applied to forestry and agriculture, but his knowledge of zoology enabled him to render further services to agriculturists by devising measures for the control of insect pests of various crops.

For about twelve years of his service Ridley with his staff of two or three European Officers serving as Superintendents or Assistant Superintendents of Gardens and Forests in Singapore, Malacca and Penang, represented the only organisation in the Colony or the Native States, as they were then known, to which agriculturists could apply for technical advice and assistance. The need for such assistance naturally increased steadily throughout this period, since it covers the early extension of large scale agriculture in the Malay States. When it is remembered that the whole period of his service corresponds closely with that of the growth of the rubber industry in this country from its earliest infancy to the great boom of 1910–1911, it becomes possible to realise how great were the calls made on Ridley and his staff. The demands from the agricultural community for planting material of Para rubber and for advice on every aspect of this new and quite unknown crop occupied in themselves a large share of the time of Ridley and his assistants.

In spite, however, of the demands of the growing rubber industry and the claims of the more purely scientific aspect of botany as represented by the maintenance of the Botanic Gardens in Singapore and the collection, identification and description of local plants, Ridley was able to carry out work on a range of plants which comprised most of the actual or potential tropical crops known.

Ridley's work on rubber is dealt with in a separate article in this number, so that the remarks which follow deal only with some of his work on other crops.

The Economic Garden.

In 1888 when Ridley assumed duty there was in Singapore under the Forest Department, an Experimental or Economic Garden near the Botanic Gardens, in which experiments were in progress with English vegetables and fruit trees of various kinds, together with trials of patchouli, coca (the plant from which cocaine is obtained) cubebs peper, ordinary black pepper, cacao, tapioca and various trees yielding rubber. In 1889 Ridley recommended that this Experimental Garden should be removed from the Forest Department and be placed under the Gardens vote. In making this suggestion he wrote :—

> "I hope to increase the area under cultivation this year and, wherever I can, to make the whole an Economic Garden worthy of the Colony".

In the following year this transfer was effected.

In the years which followed Ridley gradually increased the size of this Garden and added to the collection of economic plants which it contained, until in his Annual Report for 1906 he was able with full justice to write of it :—

> "This part of the Gardens has steadily increased in usefulness and importance, not only to the local community but to all the tropical parts of the Empire, and indeed it would be difficult to over estimate its utility. All tropical plants are experimented with and stocks of all for which there is or is likely to be an exceptional demand are maintained in considerable quantities. It may give some idea of the work carried out if it is mentioned that during the year plants or seeds have been despatched on sale to countries as remote as the West Indies, including Cuba, Samoa, Honolulu, Queensland, New South Wales, West Australia, Fiji Islands, Philippines, New Guinea, China, Hongkong, Borneo, Sumatra, Java, India, Ceylon, Egypt, Lagos, Nigeria and Madiera, while the local demand from the Colony and Federated Malay States has increased enormously".

Two of the objects of this Garden are clearly stated in the paragraph quoted, namely to experiment with all known tropical crops, or tropical plants likely to prove of economic value, more especially as regards their suitability for cultivation locally, and to provide planting material of those for which there was a demand. It also served a third purpose by providing demonstrations to visiting planters of the alternative or new crops in which they were interested.

In addition to the Economic Garden in Singapore there were in the earlier part of this period two other localities in the Colony where work on economic crops was conducted.

One of these was the Bukit Sebukor Experimental Garden in Malacca. This was under the Forest Department and was used partly as a nursery for forest trees and partly for experiments with agricultural crops such as Mauritius hemp, tobacco, castor oil, pepper, Maltese oranges and lemons, cloves, nutmegs, Liberian coffee, tea, cacao and Egyptian cotton. The cotton and cacao were not successful. Liberian coffee was considered to require manuring on poor soil. The tea, a Hybrid Assam type, did fairly well, as did the nutmegs and cloves on the better soil in this garden. In 1893, however, on the recommendation of the Retrenchment Committee of that year this garden was abandoned, partly because much of the soil on this site was very poor.

Another locality was the Hill Nursery and Government Bungalow Garden on Penang Hill. The Nursery was used for trials of fruit trees and it is mentioned in the Annual Report for 1888 that an apple tree from Australia bore 8 fruits of large size and fair flavour, but olives produced no fruit. In 1891 an avocado pear tree in this Nursery fruited for the first time and in 1894 three of the same trees bore a heavy crop. Lechee, loquat, olives and peaches do not appear to have produced fruit and oranges from Malta gave a few fruits, but of moderate flavour and not in economic quantities. The bungalow garden was used for raising vegetables of which, according to the Report for 1894, carrots, beet, leeks, lettuce, khol rabi, radish, peas and in the dry season tomatoes were the most successful. In 1898 potatoes gave a fair crop but several were diseased. The great handicap on the Hill was the expense of farmyard manure when the charges for transport, in the absence of a a road or railway, were added, while another expensive item was the construction of a terrace round each fruit tree to prevent soil erosion by heavy rains. Little work was done in this fruit nursery after 1897 and an attempt was made to reafforest the site with useful trees in 1900. The Bungalow Garden was, however, regularly upkept and continued to give a supply of vegetables.

The Waterfall Gardens in Penang provided little room for work on econmic crops, but well known tapping trials on one of the rubber trees in that Garden were commenced in 1898 by the Assistant Superintendent, Mr. Curtis, and were maintained for at least eleven years. Other economic activities at this garden were mainly confined to raising young plants for trial on estates in the island or in Province Wellesley. Thus in 1896 Mr. Curtis raised a fairly large number of Borneo sugar canes from seed and in the following two years distributed them for trial on estates. From 1895 to 1897 a stock of Ramie fibre plants was built up for distribution and some interesting observations on varieties of this plant were made. In 1903 and 1904,

Mr. Fox, then Superintendent, carried out experiments with Egyptian and Sea Island cottons. These experiments in conjunction with those carried out on estates in the Settlement led him to conclude that in the cultivation of cotton the Straits Settlements could not compete with other cotton growing countries.

In the Malay States, Sir Hugh Low planted Hevea rubber trees a few other economic trees behind the Residency at Kuala Kangsar in 1878 and following years, but there was no Experimental or Economic Garden of much size or importance until Mr. Arden, Superintendent of Experimental Plantations, Selangor, commenced the establishment of the Batu Tiga Plantation towards the end of 1902.

In these circumstances the Economic Garden in Singapore was the chief source of information on various crops and of planting material for the whole Peninsula, until such time as the Department of Agriculture, Federated Malay States, created in 1904, had developed sufficiently to take its share of this work.

Examination of the Annual Reports of the Botanic Gardens, Singapore, shows how wide a range of plants was tried and reveals several points of interest.

Throughout the period of Ridley's tenure of office there was a demand, varying somewhat from time to time, for planting material of most of the well known local crops, such as pepper, cloves, nutmegs, tapioca, gambier and local fruit trees. These call for little comment beyond the fact that six good varieties of tapioca from British Guiana were introduced in 1888.

Until the cultivation of Para rubber began to monopolise attention in the first decade of this century, a number of plants were tried in the Economic Garden with a view to ascertaining those which would be most suitable for use in large scale agricultural development in the Peninsula. Beverages included a collection of varieties of cacao obtained from Ceylon in 1883, a collection of different species of coffee assembled gradually, and Assam, China and Paraguay tea planted in 1891. In 1888 the cacao fruited well and it was stated that there was no reason for its failure if properly cultivated, and that it might be profitable in the Peninsula where the soil was better than in Singapore. In later years there was some demand for planting material for trial, but it never seems to have proved entirely satisfactory. In the nineties there was a considerable demand for liberian coffee for the estates in Selangor and Perak and some demand towards the end of that decade for Stenophylla. It is peculiar that so little interest seems to have been taken in the possibilities of tea cultivation during these years, seeing how promising it has shown itself to be in the last few years on both the plains and hills of this country.

The collection of fibre plants assembled in this Garden included Ramie, Cottons of various kinds, Manila hemp (*Musa textilis*), various species of Sansevieras (Bowstring hemp), Mauritius and sisal hemp, *Fourcroya gigantea* imported from Barbados and some Bromelias. Ramie cultivation attracted considerable attention up to about 1904 and Ridley had hopes that the cultivation of this and some other fibres would gradually come to occupy the definite place in the agriculture of the country which he considered that they deserved, but the overwhelming importance of rubber caused them to be neglected in later years. In the years 1903 and 1904 shortage of the cotton crops in America emphasised the importance of this cultivation throughout the Empire. Numerous varieties of this plant were imported but did not prove successful. Ridley states:—

> "The climate and soil of Singapore seems, however, quite unsuited for cotton culture, owing to the excess of rain, and the red cotton bug, *Dysdercus cingulatus,* in spite of the use of insecticides, destroyed nearly all the pods".

This conclusion was supported by that of the trials in Penang, referred to above, and agrees with the results of trials conducted in more recent years by the Department of Agriculture, S.S. & F.M.S., so far at least as the western side of the Peninsula is concerned. Mauritius hemp did well, but sisal was not a success. Both these plants grew satisfactorily in trials during the last ten years at the Central Experiment Station of the Department of Agriculture in Selangor, but they gave little prospect of profitable cultivation except at high prices for the fibre. The Sansevieras never became of much importance, but it is still possible that Manila hemp may prove a useful crop on certain types of soil in this country.

As early as 1888 the annual value of the preserved fruit export from the Colony, chiefly preserved pineapples, was $100,000, and in view of this Ridley imported in 1892, 1893, and 1895 better kinds of pineapples which included hot-house varieties from Kew and Windsor Castle and West Indian strains from Trinidad and Jamaica.

Various other kinds of fruits were imported and tried. It is impossible in the space available to enumerate these, but a few records of interest may be mentioned. Figs fruited in 1888 and the following year, but the fruits were of poor flavour. In the first of these years the tree tomato was a failure in Singapore, although it has in recent years grown and fruited well on the hills of this country. The avocado pear fruited well in 1892 and more seeds from Kew and Trinidad were imported. In view of its success both in Singapore and on Penang hill it is remarkable that even now this fruit, so popular in many parts of the tropics and sub-tropics, is still comparatively rare and of little account here. Mangoes from Madagascar and grafted kinds from Calcutta were imported in 1903, but the grafted kinds

of this fruit have so far never done well in this evenly moist climate. In 1890 Maltese lemons fruited well, giving fruits of good size and flavour, but even to the present day this fruit has attracted but little attention.

Summarising the results obtained with English vegetables in 1888, Ridley states that Tomatoes and Jerusalem artichokes did well, while turnips, onions and carrots gave fair results, though the flavour of the carrots was poor and they were apt to be small and stringy. In 1889 he mentions the successful cultivation of water-cress.

In 1907 when rubber was beginning to secure its place as the main crop, Ridley received numerous enquiries for suitable catch crops for planting in the young clearings. He was not able to give this matter the attention which he felt that it deserved, but in the following year he mentions that Ground-nut, Citronella and Lemon grass were in demand for this purpose.

Although in the early days of rubber planting the fetish of clean weeding held away, Ridley in 1909 planted up plots of crotalarias, tephrosia, desmodiums cajanus, clitoria and other leguminous plants which he considered suitable in various degrees for covering and improving the soil of rubber and other estates.

In 1907 an article in the "Agricultural Bulletin" called attention to the value of the Oil Palm as a cultivated crop and resulted in the distribution of 3,030 seeds. Substantial developments did not follow until some 10 more years had elapsed, but this record may well mark the beginnings of what is now a well established industry.

Considerations of space forbid reference to a number of other plants of various kinds grown in the Economic Garden in Singapore, but the following taken from the report for 1907 gives a picture of the extent of the planting material distributed :

Para Rubber seeds 405,600 and 13,100 plants, Ramie 3,170, Sanseviera 10,000, Manila hemp 130, Mauritius hemp 150, fruits of various kinds 1,700 plants and 12,000 seedlings, Tapioca 300 plants, Coffee 125, Citronella 160, Lemon grass 250, Camphor 750, Cocoa 160, Nutmeg 172, Oil Palm 3,030 seeds, Ground nuts 50 lbs. seeds. Most of these were sold to the Federated Malay States and Johore, but some went to Lagos, British New Guinea, Southern Nigeria and the Caroline Islands.

Pests and Diseases of Crops.

Early in his period of office Ridley drew attention to the damage caused to coconut palms by the black beetle (*Oryctes rhinoceros*) and the red beetle, as it was then known, (*Rhyncophorus sach*). The outcome of this was the passing in July, 1890 of the Coconut Trees Preservation Ordinance. Asiatic Inspectors were appointed in Singapore under the Director of Gardens and in Penang Settlement under the Superintendent of Gardens to

ensure that all suitable breeding places for these insects were cleared up. Similar legislation was provided about the beginning of this century in the Federated Malay States and until 1913 was administered by the Inspector of Coconut Trees and his staff.

In 1896 Ridley published a bulletin on the disease of nutmegs in Penang due to a Scolytid beetle and another on diseases of coffee. In 1899 he visited the districts in Selangor which were affected by the plague of the coffee caterpillar (*Cephonodes Hylas*) investigating its life history and trying experiments for its control. He also investigated and gave advice on certain disease of rubber and the white ant (*Termes gestroi*) attacking rubber and coconuts.

Among other pests and diseases recorded by him were Sireh disease on sugar cane in 1889 and in 1898 a borer caterpillar (*Chilo spp.*) and red smut fungus on the same crop, while there is also a record in the same year that the beetle *Xylotrupes gideon* damaged canes in Province Wellesley by eating the roots. In that year damage to coffee by a locust (*Cyracanthus nigrovaria*, Walk.) is noted and also by a fungus believed to be a species of Irpex. The Banana weevil (*Sphenophorus sordidus*) was recorded in 1899 together with the rose sawfly and a species of the fungus Rosellinia on the roots of a species of Ficus. In 1900 there is a note on the beetle, *Batocera octomaculata*, boring in the branches of Rambong (*Ficus elastica*); the life history of the caterpillar, *Calogramma festiva*, a Noctuid moth was worked out; and a caterpillar pest proved very destructive to young plants of Getta Percha.

In this connexion it is interesting to note that in 1909 Fox records that coconut palms on Malakoff Estate in Province Wellesley were badly attacked by the larvæ of a small moth and that for a few months the trees presented the appearance of having been burnt. Judging from this description it would seem that this constitutes an early record of an outbreak of the pest *Artona catoxantha*.

Agricultural Bulletin.

It was necessary for Ridley to find some means, additional to ordinary correspondence and personal visits, for conveying to the planting community information resulting from his various investigations and experiments. For this purpose he issued between 1895 and 1900 Agricultural Bulletins on various subjects, which were published as information became available. In October, 1901 he commenced to issue monthly "The Agricultural Bulletin of the Straits and Federated Malay States," which he continued to edit until his retirement in 1911. This was supported by numerous contributors and correspondents including officers of the Forests and Agricultural Departments established in the Federated Malay States during those years, as

well as several leading planters, but Ridley himself was always a regular contributor in addition to carrying out the considerable task of editor. This publication contains a mass of interesting and valuable information on a number of crops besides rubber, and shows, as do his other activities, that Ridley was no believer in placing all the agricultural eggs in one basket.

Horticultural and Agricultural Shows.

Another well recognised method of propaganda utilised by Ridley and his staff was the holding of Horticultural and Agricultural Shows. A Flower Show, often including fruit and vegetables, was held in Singapore in 1889 and the following two years, but was then discontinued. A successful Agri-Horticultural Show was held in Penang in 1893; another at Butterworth in 1899; and again in Penang in 1901. In 1904 a Show was held in Kuala Lumpur, but what was then described as probably the largest Exhibition of its kind ever held in the East took place in Singapore in 1906 and was attended by visitors and delegates from Java, India, Ceylon and Burmah. This was followed by Annual Shows at different centres such as Kuala Kangsar and Kuala Lumpur until 1910 when the last of the continuous series was held in Singapore.

It is hoped that the above account will give some conception of Ridley's multifarious activities on behalf of Agriculture in Malaya.

Since the days with which this article is concerned, the development of agriculture in the Federated Malay States, which resulted in the creation in 1904 of what is now the Department of Agriculture, Straits Settlements and Federated Malay States, and the establishment in 1926 of the Rubber Research Institute, has caused the transfer of agricultural investigation work from Singapore to Kuala Lumpur and as a result the Economic Garden in Singapore has been abandoned. Ridley himself lives far away, enjoying a well earned retirement in England. But in spite of these changes the agricultural structure which has arisen on the foundations which he so securly laid remains as his permanent memorial in Malaya.

MR. RIDLEY AND RUBBER IN MALAYA.

By B. J. Eaton,

Director, Rubber Research Institute of Malaya.

As the name of the late Mr. (later Sir) Henry Wickham is synonymous with the introduction of the rubber tree to the eastern tropics, so the name of Mr. Ridley is synonymous with the establishment of the Para Rubber Tree (*Hevea brasiliensis*) as a commercial plantation product in Malaya.

An anonymous article (probably by Ridley) published in the Agricultural Bulletin of the Straits and Federated Malay States (1903) gives the history of the introduction of the Para rubber tree into the Malay Peninsula. A few extracts from this article will therefore be appropriate in an appreciation of the work of Ridley in connection with rubber cultivation in Malaya.

On August 11th 1876 fifty plants derived from seeds received from Wickham on June 14th 1876 and grown in the Kew Gardens were sent to the Botanic Gardens Singapore. Owing to delay in payment of freight these plants all perished.

On June 11th 1877, twenty two plants were sent to the Singapore Gardens. In October of the same year Mr. Murton, Superintendent of the Gardens, planted nine of them in the Residency Gardens, Kuala Kangsar, F.M.S.

In a report dated February 3rd 1879 Mr. Hugh Low (then British Resident of Perak) writes "The Heveas are now 12–14 feet high. They take to the country immensely".

In a letter dated December 11th 1896 Sir Hugh Low writes to the Kew Gardens "As I am writing I should like to mention that the *Hevea brasiliensis* which having received from Kew through Singapore I planted at Kuala Kangsar in Perak grew magnificiently and fruited I believe 2–3 years before those of Ceylon. I distributed the seeds to various places in the neighbourhood and they are now to be found in Mr. Hill's Coffee Gardens in various parts of the peninsula and in several places in Perak.

"When Mr. Swettenham was at home in the summer I enquired of him as to their condition and found they were not thought to be of any value as some Dyaks had tapped some of the largest trees and found that scarcely any juice exuded from them (*Note:*—The effect of "wound response" on yield had not then been discovered). This unfortunate statement seems to have deterred Perak planters from paying any attention to Para rubber for some time". In 1882 other seeds obtained by Sir Hugh Low were planted by Mr. Wray at Kuala Kangsar.

In 1881 Mr. CANTLEY of the Botanic Gardens Singapore writes "the tallest Hevea (in the Gardens) is now 25 feet tall and 14 inches round the base. These trees commenced to fruit in 1882."

Later seeds were received in large quantities from Ceylon.

It was not until 1897 that the high price of rubber and low price of coffee stimulated the interest of planters (*Note:*—Had interest been aroused earlier and extensive planting taken place, the extraordinary boom of 1910 due to the rapid development of the motor industry would probably not have occurred).

Mr. RIDLEY served as Director of Gardens Singapore from 1888 until 1911. During most of this period—from 1888 until 1905—he was largely responsible for advising on agriculture throughout the peninsula, although during the later part of this period in the Federated Malay States, two Superintendents of Plantations in Perak and Selangor and a Federal Inspector of coconuts were employed by the Government before the inauguration of the Department of Agriculture F.M.S. in 1905.

Ridley thus remained in Malaya sufficiently long to see the fruition of his labour in regard to the commercial exploitation of the rubber tree (*Hevea brasiliensis*) in the extraordinary boom in rubber prices which reached its culminating point in 1910 and which was responsible for the subsequent extensive development not only in Malaya but also in the Netherlands Indies.

The writer of this article need make only a passing reference to the many-sided nature of his work in connection with other economic crops and in relation to his systematic work on the flora of Malaya, since this is being dealt with by others. Details of his work on numerous economic crops are contained in Annual Reports of the Botanic Gardens and Forests Department, S.S., of which he was also Director for some years and in the Agricultural Bulletin, S.S. which he initiated and edited for many years.

During the period prior to 1905 he was responsible for the distribution of an enormous amount of rubber planting material, seedlings and seeds from the experimental area planted in the Botanic Gardens Singapore, which formed the beginning of the oldest plantations in the peninsula. This activity is particularly noticeable from the years 1897 onwards. During this period also various systems of tapping and methods of coagulation were experimented with under his direction.

He also realised the possibility of utilising the seeds of the rubber tree as a source of oil, although for various reasons the marketing of seeds for this purpose has not developed on a commercial scale.

In 1903 he carried out certain manurial experiments with rubber plants in beds and showed the value of cattle manure in

improving growth. Experiments under his direction also indicated that early morning and evening tapping gave the best results.

In 1904 rubber seeds from the Botanic Gardens were sent to Burma and in the following year to Jamaica, Lagos and Nigeria. It is perhaps fortunate that these did not develop successfully in various countries to which they were despatched.

One interesting fact emerges from Mr. RIDLEY'S Annual Report for 1909 which is probably not known generally, *viz.* that the Government grant for the upkeep of the gardens was only sufficient to keep them in a respectable condition and was insufficient for tools, stores and improvements, so that the revenue derived from the sale of rubber and rubber seeds was used for this purpose. He had indeed to bemoan the fact that by 1909 plantation seed had become available—thanks to his distribution of seed in previous years—and was able to compete with his own sales. On this account he was seriously considering concentrating on running his rubber area as a plantation in order to make sufficient revenue from sales of rubber to enable him to continue improvements in other directions. It is obvious therefore that "retrenchment" is by no means new in the history of Malaya.

In this year also the records show that one tree in the Penang Gardens tapped every year (not continuously as at present) since 1885 had yielded approximately 52½ lbs. over the period.

It is also reported that "the success of this marvellous product reached a height little dreamt of a few years ago, prices well over 9 (shillings) a pound being realized". In spite of this however it is amusing to note in the report of the late Mr. FOX who served under Ridley in the Penang Gardens, that a small parcel of rubber sent home in October was withheld as the sales were unfavourable ! !

The honour of a C.M.G was conferred on Mr. RIDLEY on his retirement from Malaya and he was also elected a Fellow of the Royal Society for his botanical investigations.

In addition to continuing his publications on the flora of Malaya, he is still a member of the Technical Sub Committee of the London Advisory Committee for Rubber Research (Ceylon & Malaya) and thus continues at the age of 80 to maintain his interest in an industry of which he may be said to have witnessed the birth. Those of us who knew his personally as a fellow scientist and friend join in wishing him Many Happy Returns of the birthday which he celebrates this month. We in Malaya, not to mention other rubber growing countries in the East owe him a considerable debt of gratitude for his pioneer work in connection with the plantation rubber industry and his optimism and faith in its future.

MR. RIDLEY AND FORESTRY IN MALAYA.

It is never an easy matter to assess the value of the services of a biologist in any particular field, and when the boundaries of the fields are as obscure as those that surround forestry and agriculture, differentiation becomes impossible. Nearly every issue of the official organ of the Indian Forest Service———the *Indian Forester*———contains articles on crops that nobody in this country would connect with forestry, but which are regarded as coming within the purview of the Forest Department in India. Coming nearer home there is the case of rubber. Rubber started as a forest crop, but general responsibility for government activities and experimental work was, for purposes of convenience, subsequently vested in the agricultural authorities. Are Ridley's attainments in this field to be labelled forestry or agriculture? It may be supposed that Ridley was not particularly concerned at the time with the labels on the pigeon-holes in which posterity intended to docket the records of his activities, and we do not think that he will worry a great deal now if some of them have got a bit mixed.

That he was alive to the importance of maintaining supplies of timber goes without saying, and it is to Ridley that we owe the constitution of reserves in Malacca, whose forests would have been in danger of total dissolution during the rubber boom but for his foresight. The same applies to Penang, for aesthetically spoiled though that delightful settlement may be from the clearing of hill forest, it would have been completely ruined had reservation not put a stop to the (mostly unremunerative) efforts of cultivators on the hill sides. In Singapore, the reserves are of less importance and have been virtually abandoned. When Ridley arrived the damage had already been done, and the areas available for reservation were, for the most part, already past praying for as forests, though possibly worth considering for reafforestation, an aspect of forestry that loomed very much larger in the Straits when comparative ignorance prevailed with regard to the resources of the interior and communications were chiefly remarkable by their absence. Such plantations as were formed were, for the most part , confined to denuded tracts of country, and except for a patch of quite fair mahogany and some unhappy line plantings of high forest forms that continue to receive a certain amount of attention at Bukit Beruang in Malacca, little trace remains of these early efforts.

In 1895 Ridley paid a visit to Selangor and reported on the forests of that state which, at that time, were in nominal charge of the Land Officers, and it was largely due to his report that the first Forest Officer, Mr. B. H. F. Barnard was appointed in that State. He subsequently accompanied Mr. H. C. Hill, who was seconded from the Indian Forest Service to report and advise on

the forests of the F.M.S., a step which led to the appointment of Mr. A. M. Burn-Murdoch and the establishment of the Forest Department as a combined Federal and S.S. organization in 1900.

So much for his direct activities. Valuable though they undoubtedly were they were as nothing compared with his work in the field of systematic botany and plant economy. Thanks chiefly to Ridley, the Malayan forest organization was able to start off with immeasurably more knowledge of the composition of the forests than is the common lot of tropical foresters generally. Without his *Flora of the Malaya Peninsula* and *Malay Plant Names* most of our *Forest Records* would have been very incomplete or might never have been written. Though essentially a systematist he never allowed himself to be tied to the herbarium, and his contributions to the *Agricultural Bulletin* included invaluable field notes on timbers and on the uses and sources of all kinds of minor forest products. That there were inaccuracies goes without saying, but it was just that quality of recklessness in Ridley's work that enabled him to turn out such vast quantities of assimilable knowledge when it was most needed. A lesser man would have feared for his professional reputation, but Ridley was above such petty considerations. The work needed doing, and with the means at his disposal he did it magnificently.

Mr. H. N. RIDLEY AND THE FLORA OF THE NETHERLANDS INDIES.

By D. F. VAN SLOOTEN,

Acting Director, Botanic Gardens, Buitenzorg.

The series of island-groups, which extend from further India to Australia, and which are situated between 95° and 141° east longitude and between 6° north and 11° south of the equator, belong to the overseas territory of the Kingdom of the Netherlands, with the exception of the Philippines, Sarawak and British North Borneo, Portuguese Timor, Christmas Island and the Territories of British New Guinea. If one compares the extent and area of the Netherlands East Indies with those of Europe or the United States of America, one finds that the east to west extent of the N.E.I. is approximately equal to the distance from the West Coast of Ireland to the East Coast of the Caspian and from 7° to the West of San Francisco to 7° to the East of New York, the maximum length from West to East of the Netherlands East Indies (*i.e.* from Pulau Weh to Humboldt Bay) being about 5,000 km. The maximum distance from North to South is 2,000 km., which is equal to the distance between Oslo and Rome and as far as from the North coast of Michigan Lake to New Orleans (Louisiana).

The total area covered by all the islands of the Netherlands Indian Archipelago measures 1,900,152 km.², which equals about half the size of Europe, excluding Russia. In order to give some idea of the size of the islands we mention the following details: *Java,* including Madoera, has an area of 131,508 km.² (*i.e.* about the same size as the State of New York), *Sumatra* with the surrounding islands an area of 420,384 km.² (exceeding the area of Great Britain), *Borneo,* as far as the Dutch territory is concerned, covers an area of 553,341 km.² (which is as large as France), *Celebes* and the small islands in the immediate neighbourhood an area of 185,914 km.² (being about the same size as New Zealand and Ceylon taken together) and the Dutch section of *New Guinea* one of 397,204 km.² (*viz.* the same area as Japan proper), while the rest of the Archipelago measures 211,801 km.²

The botanists, who have to study the vegetation and the immensely rich flora of an area covering approximately 1,900,152 square kilometers, have to perform—as everybody will understand—a very difficult and lengthy task. Though the climatic conditions (uniformity of temperature and changes in rainfall, both intensified by the high mountain ranges which intersect the

islands) are very similar throughout this vast tropical area, so that the number of vegetation types is very limited, yet from the differences in the local soil conditions (water, edaphic factors, volcanic material, etc.) has arisen such a complex flora, that the very same vegetation-type shows in various places a large diversity as to the constituent flora-elements.

The total flora of flowering plants may confidently be estimated to comprise 30,000 species, belonging to about 2,500 genera. It will be many years yet before all islands of the Archipelago are intensively explored botanically and before such a wonderfully rich flora is thoroughly known, the more so as the flora of each island presents a small or high percentage of endemic species. This flora could not form a subject of systematic investigation until the foundation of the Botanic Gardens at Buitenzorg in 1817. Its study was taken up energetically by the second Director of the Gardens, C. L. Blume, and has been continued up till the present.

This study is progressing but slowly, on account of the vastness of the territory, and also of the fact that during many years this task was entrusted to a few botanists only. Moreover, in Buitenzorg the standpoint is taken, that our knowledge of the flora ought to be based on a thorough monographic study of the families; this has found expression in contributions to the *Bulletin du Jardin Botanique de Buitenzorg*. To further this object, contact has long been developed with botanists from abroad for co-operation in the study of the Malaysian flora. The researches of those botanists who concern themselves with the study of a closely related flora, are therefore of direct importance. Many individuals are cited in literature as having studied more or less botanical material from this Archipelago. Among the most prominent of these is Mr. H. N. Ridley.

Mr. Ridley's course of life once more proves how profitable it is for men of outstanding ability to be employed in the tropics for a considerable period of years; in this way important work can be accomplished without interruption and along the same lines. Well-known examples of this are the celebrated Rumphius, Teysmann and Treub, the last two of whom by their very long service in the tropics were able to found and consolidate the Botanic Gardens at Buitenzorg.

It has been given to Mr. Ridley also to spend a long period in the tropics, as a result of which he became one of the founders of our knowledge of the flora of the Malay Peninsula. Being evidently very zealous in fulfilling his botanical duties, he based the study of this flora not only on herbarium specimens, but also himself collected large numbers of plants during inspection trips.

His large collections, of which he deposited duplicate sets in many herbaria, including Buitenzorg, form, with other older ones, the essential basis of our knowledge of the exceedingly rich flora of the Malay Peninsula. He did not confine his trips to this Peninsula, but he also made expeditions to the Malay Archipelago, *viz.* to Christmas Island (1890 and 1904), Java (1915), Sumatra (1897 and 1921) and Borneo, as a result of which he was in a position to compare the floras of these regions. So far as the Netherlands Indies are concerned, it is only from New Guinea that he has studied an important collection of plants without having visited the country of origin. The number of species he named as new to science amounts to a few thousands; the number described by him from the Netherlands Indies (including British North Borneo, Sarawak and British New Guinea) so far as I have been able to trace—is 1,053, divided over the different islands as follows: British New Guinea 391, Sumatra and surrounding islands 329, Sarawak British North Borneo and Dutch Borneo 322, Java 6, Celebes 2, Ambon, Key and Aru Islands each 1.

Now it may be true that the majority of these plants described as new by Mr. RIDLEY originated from outside the Netherlands Indies; but phytogeographically the flora of the Malay Archipelago appears to be so closely related to that of the Malay Peninsula, that the systematic work of RIDLEY implies an important progress for our knowledge of the flora of the Malay Archipelago also.

Already before he became Director of the Botanic Gardens at Singapore, *viz.* in 1884, he published in the Journal of Botany some articles about the flora of the Malaysian Archipelago; the description of a new Bornean orchid (a new diagnosis of *Didymoplexis sylvatica* (Bl.) RIDLEY) belonging to the Javan collection of HORSFIELD, formed the first contact. In 1885 he described in the same journal a new *Carex* (*viz. C. tartarea* RIDLEY), collected in Sumatra by Dr. H. O. FORBES, while one year later he published a study on the Monocotyledonous plants of New Guinea, collected by the same (followed in 1925 by a study of FORBES'S Javan and Sumatran Monocotyledones). Later, various contributions about the flora of the Malay Archipelago have been issued, most of them concerning Borneo and Sumatra.

RIDLEY made his first visit to Sumatra in 1897, to the Siak district in the South. He did not have a second opportunity for a visit to this island until 24 years later; he jumped at this occasion as he "was anxious to visit other parts of Sumatra before (his) Eastern travels came to an end". In spite of the great amount of work which has since been done, the beginning of RIDLEY'S account of this botanical excursion to Northern

Sumatra, *viz.* to Brastagi and the Sibayak Volcano is still true: "The flora of Sumatra is at present still very little known, so that the account of even a short excursion especially in the quite unexplored northern part of the island is a contribution to the history of its flora". To know this history of the Sumatran flora as completely as possible is the prime requisite before cultivation, which is rapidly extending, makes it impossible for ever. Owing to the marked similarities that exist between the flora of Sumatra and that of the Malay Peninsula, a thorough knowledge of the flora of the latter territory is of the greatest importance in a study of that of Sumatra, though the Sumatran flora has certain peculiar characteristics, so that MERRILL'S opinion may be correct: "So far as I can judge at the present time, somewhere between 40 and 50 per cent. of the known Sumatran species are endemic, so that no published flora of any neighbouring region can be expected to be more than an aid to the determination of Sumatran material".

As to Borneo the words of RIDLEY in 1913: "very much remains to be done even in the best-known district", agree also with the present situation of 20 years later: on account of its enormous densely forested areas, sparse population, few roads and difficult transportation, Borneo has been only slightly explored botanically. How exceedingly rich its flora is, is illustrated by the extensive and very interesting Kinabalu collections made a few years ago by Mrs. MARY and Chaplain J. CLEMENS: these collections, among the largest ever made in Borneo, are very important to our knowledge of the Bornean flora, though that lofty mountain had already received attention from several botanists. RIDLEY himself, who visited Sarawak in September 1905, has written many essays about the flora of Borneo, working through the important collections made by Dr. HAVILAND and Bishop HOSE in Sarawak.

From the foregoing it is evident that Mr. RIDLEY'S work has in large measure been devoted to systematic studies: the name of RIDLEY will always be associated with work on the flora of the Malay Peninsula. He has further been much concerned with the geographical distribution of plants and with the development of species; his interest in these subjects finds expression in several of his published papers. This also may have underlain his great work entitled *"The dispersal of plants throughout the world"*, which begins as follows: "The study of the Dispersal of Plants .....is one of very great importance in its bearing on the distribution of plants throughout the world, the causes of their presence or absence in different localities, the changes of floras at different periods and all that goes to make a local flora. It has also been an important factor in the evolution of species, genera, and, in some cases, even of orders". For long years

considerable attention was given by him to this subject : already in 1905 in his description of the botany of Christmas Island, he devoted a detailed chapter to the dissemination of the plants of this island, which presented such an excellent occasion for his purpose, being a true oceanic island, as it "has never at any time been connected with the mainland of Java or with any other land", and as "it is an extinct volcano covered with coral reefs of various ages from the eocene period to the present day".

Moreover by his studies of economic plants, RIDLEY proved that there exists an admirable opportunity for co-operative productive work. Some of his publications are of such great importance for the Netherlands Indies, that they have been translated into Dutch. In *"The Timbers of the Malay Peninsula"* (De Maleische timmerhoutsoorten) timbers are concerned, which are distributed throughout the Malayan region. However, RIDLEY'S excellent study was a valuable addition to publications already existing, in which mainly Javan timbers were described, the descriptions of RIDLEY referring for the first time to timbers from Sumatra.

RIDLEY'S *Malay drugs* (De inlandsche geneesmiddelen der Maleiers) originated in 1894 from a lecture about the Malayan "Materia medica". The medicines, used in the Malay Peninsula, agree so well in nature and even in their names with those from Java and Sumatra, that in this case too the importance of a translation is quite conspicuous.

This very year MERRILL, who has also done so much for the knowledge of the Malaysian flora, has once more broken a lance for the value of international co-operation among scientists in the introduction of part 1 of the "Chronica Botanica" (1935). Let us finish with his words, for which he could have cited RIDLEY'S work in affirmation : ".....science is necessarily world-wide in its scope. An outstanding scientific development in one country is followed with interest and appreciation in all other countries, to a degree scarcely reached in any other group of thinking people. Particularly among botanists has international co-operation been developed, ever since the need of international co-operation was indicated through the development of its basic branch, Taxonomy. Plants are not subject to political boundaries, and the problems of plant science cover the world in all fields. The continued harmony among botanists in these days of stress, international discord, and internal difficulties, as widely separated as they are in the fields in which they specialize and the institutions of which they are a part, may well influence international co-operation among other groups".

SOME MALAYSIAN PHYTOGEOGRAPHICAL PROBLEMS.

By E. D. Merrill,
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Perhaps no part of the world is more intriguing from the standpoint of phytogeography than is the great equatorial archipelago lying between southern Asia and Australia. Malaysia is by far the largest island group in the world, lies wholly within the humid tropics, has great diversity of altitudes up to nearly five thousand metres, and enjoys uniformly high low altitude temperatures, and, except in limited regions, an abundant rainfall. Almost continuous precipitation occurs over large sections, accompanied by relatively high humidity; other large areas are characterized by alternating wet and dry seasons. These factors, combined with the characters of the soils, the topography, and the position of mountain masses in relation to prevailing winds provide optimum conditions for plant growth, and the net result is a flora of tremendous richness and exuberance. The differentiation of species has perhaps been in part favored by the geologic development of the region, and its more or less insular character over long periods of time. Under present conditions contiguous parts of the same island may present rather strikingly different floras, while certain islands separated from each other by only relatively narrow arms of the sea may have very strikingly different vegetative and floristic aspects.

Some years ago on the basis of a study of endemism of those parts of Malaysia blessed with published floras or compiled enumerations, such as the Malay Peninsula, Java, Borneo, and the Philippines, I concluded that when the flora was approximately known, that in the Pteridophytes and the Spermatophytes combined its total would approximate to 45,000 species. Thus for the Malay Peninsula, Borneo, and the Philippines, considering all known species, it was found that at least fifty per cent. of those known from each major unit were endemic. Considering how relatively little was then, and still is, known regarding the floras of the large islands, including Sumatra, Borneo, Celebes, and New Guinea, I am inclined to consider that this estimate of 45,000 species is perhaps too conservative.

With a land area in excess of one million square miles, this region (including the Malay Peninsula, which is almost an island, and which is essentially a part of the Archipelago) extends from northern Sumatra to Java, New Guinea, and the Philippines, a region of magnificent distances, extending from north-east to south-east, a distance of over forty-five hundred miles. Among its many thousand islands are found the largest ones in the world: New Guinea, Sumatra, and Borneo, and such large

secondary ones as Java, Luzon, Mindanao, Celebes, Gilolo, and Timor. The magnitude of some of these major islands is well suggested by Wallace's statement that within Borneo "the whole of the British Isles might be set down, and would be surrounded by a sea of forests."

This is one of those parts of the world regarding which we have only an approximate knowledge of its flora. Certain areas, such as parts of the Malay Peninsula, Java, and parts of the Philippines, may be considered to be well-known botanically, but in fact only certain very limited parts are thoroughly known. Vast regions have been only superficially explored, and great areas have never been visited by any collector or botanist. A distinctly high percentage of the known species is known only from the single collections on which the original descriptions are based. We cannot, therefore, make any reasonably accurate comparison between any particular part of this vast region and comparative areas in what may consider to be thoroughly explored parts of Europe and North America. In any consideration of the numerous phytogeographical problems of Malaysia we are handicapped by our own limited knowledge of its exuberant flora, and must realize that future intensive exploration will yield data which may conceivably alter some of our at present accepted axioms.

Although the geologic history of Malaysia is reasonably well understood in its salient outlines much detailed knowledge is lacking. The magnificent work of the Dutch geologists and hydrographers on the geological history of Malaysia forms a basis that must be considered by those biologists interested in the present-day distribution of plants and animals, for the key to present-day distribution to a large degree is found in geologic history. Whatever the causes may have been, it seems to be evident that the great islands of Sumatra, Java, Borneo, and the Palawan-Calamian group in the Philippines were in the Pleiocene-Pleistocene at times connected with the Asiatic continent, and New Guinea had the same relationship with Australia. There is much evidence to support the idea that most of the Philippine group, Celebes, Lesser Sunda Islands, and the Moluccas, at this time in geologic history, as well as in the Tertiary, were constantly archipelagic, with no direct land connections between eastern and western Malaysia, and hence no direct land connections between Asia and Australia since the early Tertiary.

Botanists, probably because confronted by such myriads of species, have not been as prone as zoologists to delimit life zones or to map provinces. The attempts of the zoologists to establish lines of demarcation separating the Asiatic and Australian faunas are interesting. Wallace's line extending northward from between Bali and Lombok through the Macassar Strait between Borneo and Celebes is, at least popularly, the best known of these. Its most noteworthy substitute is Weber's Line, farther

to the east. If these lines are plotted on a hydrographic map the former approximates the eastern boundary of the Asiatic continental shelf and the latter the western boundary of the Australian-Papuan shelf. It is reasonably good evidence that these two shelves mark the approximate limits of previously existing continental areas. These two more or less stable areas have been constantly separated by a triangular unstable insular area, its base the Lesser Sunda Islands, its apex Luzon.

There is no sharp line of demarcation between the Australian and the Asiatic faunas and floras, but rather this unstable insular area forms a great transition zone that has been in part populated by infiltrations from the south and east and from the north and west. No proposed line is absolute for any single group, much less when all groups are considered.

It is a well-known fact that as we progress southward and eastward from Asia, the continental types of animals and plants become fewer and fewer, and as we progress northward and eastward from Australia, the Australian types likewise decrease even more markedly. This is exactly what we would expect if our present concept of the geologic history of the region is approximately correct.

One should not make the mistake of drawing final conclusions on the basis of the present-day distribution of any one group of organisms, whether it be the molluscs, insects, reptiles, birds, freshwater fishes, mammals, or plants, and much less on any single family or genus within these major groups; and yet there are conspicuous cases of broad generalizations that have been founded on the study of a single family, perhaps even a single genus. While some such generalizations may ultimately prove to be correct, it is always safer to consider what is known regarding the geographic distribution of other and perhaps totally unrelated groups and to attempt to correlate such data with what is known of the geologic history of the entire region. It is a safe assumption that the different groups have been developed and have attained their present-day distribution at different periods in geologic history; and that while some groups were rapidly differentiating, others were perhaps static or were retrograding. That the Philippine flora, as to the Myrtaceæ, shows an unmistakably close relationship with that of north-eastern Australia is no reason for considering that the entire Philippine flora and fauna is allied to that of Australia. If one studies only the Dipterocarpaceæ of the Philippines one would conclude that its flora is overwhelmingly allied to that of Borneo, Sumatra, and the Malay Peninsula. Clearly here, as with other groups, the periods of development and expansion have occurred at different times in geologic history, periods that permitted the distribution of one group perhaps restricting that of another.

Botanical collectors who have explored Malaysia compared with those who have worked in Europe and in North America, north of Mexico, have been few, and the number of botanists who have familiarized themselves with what has been published is fewer still. For all practical purposes those botanists who have concentrated on a study of the floras of the Malay Peninsula, Sumatra, Java, Borneo, the Philippines, and New Guinea, in the past two hundred years are merely the pioneers, and their work should be considered as that of pioneers, to be correlated, polished, and evaluated by future generations of botanists who will have infinitely more to work with than did those who first exploited the fertile fields of Malaysian botany. It will be many years before the essential data are assembled on which we may base final conclusions. Even such work as has been done by various taxonomists on the Malaysian flora working in scattered centres in Europe, England, and America, in Manila, Singapore, Buitenzorg, and Calcutta, has not been well correlated. Much needs to be done to prove the validity or non-validity of some thousands of proposed species. Many points can be settled only when competent taxonomists, having access to comprehensive collections, shall have had the time and opportunity to prepare and publish authoritative revisions of numerous natural groups. As this is done, and as type collections and other authentic material are critically studied and the species carefully compared with each other, nomenclatural changes and many reductions of proposed species will be the order of the day. In accordance with the current aims and methods of botanical work such changes will be inevitable. In the more thoroughly explored parts of the world, and in those countries where their floras have been long and intensively studied, we approach a condition of finality but in such vast regions as Malaysia, where great areas still remain to be explored and even existing collections have not been intensively and comparatively studied, our taxonomic conclusions cannot be other than approximate.

It has long been known that within Malaysia we find what we consider to be Asiatic and Australian types. To a much lesser degree we find scattered African and Mascarene types from the west, Polynesian ones from the east, and New Zealand and New Caledonian ones from the southeast. Both the Asiatic and Australian types include high and low altitude forms. In reference to the high altitude and some of the low altitude Asiatic types we are reasonably confident that they actually are continental in origin, because in such genera as *Taxus, Pinus, Ulmus, Salix, Acer, Primula, Gleditsia, Lilium, Anemone, Sedum, Rosa, Buxus, Potentilla, Lysimachia, Aster, Solidago,* and many others, the numerous species are characteristic of the north temperate zone of both hemispheres. The occurrence of scattered species in Malaysia is unquestionably due to the fact that somehow at some

time in geologic history these representatives of northern genera extended their ranges southward into Malaysia and have persisted there.

As to the Australian types in Malaysia such as *Eucalyptus, Centrolepis, Patersonia, Drimys, Clianthus, Stackhousia, Pimelea, Tristania, Leptospermum, Melaleuca, Xanthostemon, Halorhagis, Didiscus, Stylidium,* and others, we can also be reasonably certain that they are true Australian types because of the great development of these genera in Australia and, to a certain degree, in New Caledonia; and that the few representations in Malaysia migrated northward into the archipelago even as the Asiatic types migrated southward into Malaysia.

There are, however, a very large number of genera common to north-eastern Australia and Malaysia and southern Asia and Malaysia, some covering the entire range from Asia to Australia, whose origins it is practically impossible to determine and to assign to Asia ratner than to Malaysia or *vice versa.* Doubtless many of these were originally Malaysian and extended their ranges southeastward to Australia and northward to Asia, but many others probably Asiatic. Their universal distribution within the monsoon region is unquestionably in part a reflex of the adaptability of these plants to a certain type of climatic conditions.

There are relatively few African and Mascarene types in Malaysia, such as *Angræcum, Combretodendron (Petersia, Petersianthus), Erythrophlæum,* and *Baphia,* but definitely they are African and Mascarene because the principal development of species in these genera (at least *Erythrophlæum, Angræcum* and *Baphia*) is found in those regions. When we come to the so-called Polynesian types in Malaysia, such as *Vavæa, Joinvillea, Dolicholobum, Tetraplasandra,* and *Couthovia,* the present indications are that they are not really Polynesian types in Malaysia but are actually Malaysian types in Polynesia, the generic types merely having been first described from the latter region. Thus *Vavæa* is now known to occur from Java, Borneo, the Philippines, and New Guinea; and New Guinea in definitely the center of origin and dispersal of *Couthonia* and of *Dolicholobium. Joinvillea* and *Tetraplasandra,* both small genera, have Malaysian representatives.

The numerous definitely Asiatic types in Malaysia apparently followed certain distinct routes of migration into Malaysia from the continent. In the west unquestionably the most important route was through the Malay Peninsula to Sumatra, Borneo, Java, and even further to the south and east. Considerable evidence leads us to believe in the existence of a secondary western route from Asia through the Andaman and Nicobar Islands to Sumatra. In the east, considering the fact that certain Asiatic types occur in the Philippines and in Celebes, but are absent from other parts of Malaysia, there was apparently another route from southeastern Asia to Formosa and the Philippines and

southward. We find in Formosa and on the higher mountains of northern Luzon certain Himalayan types, in many cases these representing the most eastern and southern extensions of the Himalayan flora.

Increasing knowledge of the biology of Malaysia is tending more and more to confirm the belief that there have been two great centres of origin and dispersal of tropical types, one in the west, the Sunda Islands, Java, Borneo, Sumatra, and the Malay Peninsula, and one in the east, New Guinea. From the latter plants and animals migrated southward into eastern Australia, eastward into Polynesia, and northward into the Philippines, few extending westward to the Sunda Islands From the Sunda Islands the striking migrations were northward into tropical Asia, northeastward into the Philippines, and to a more limited degree eastward and southward in the direction of New Guinea. There were, of course, intermigrations within each area.

Comparative studies of the climates and plants in tropical Asia and Malaysia with those of America, emphasizes one striking difference. In America the humid tropics are to a large degree separated from the temperate regions by extensive arid areas. In the Old World the intervening arid regions are lacking. There has been a continuous humid north and south route connecting Malaysia with subtemperate and temperate parts of Asia—the Malay Peninsula northward through Burma, Siam and Indo-China, to India and southern and eastern China. The limiting factor here has been largely temperature, while in America it has been aridity and temperature combined. We have little evidence on which to base conclusions as to what the humidity and aridity of the various parts of Malaysia may have been in past geologic times, but the available paleobotanical evidence seems to indicate continuously humid tropics in the past, in general similar to the conditions existing to-day.

Outside of the taxonomic field, but nevertheless intimately associated with and dependent upon it, there are an infinite number of problems to be settled regarding the Malaysian fauna and flora. In part these depend on an intensive study of existing collections of reference material, in part on long continued intensive field work. What was the original flora of Malaysia? What are to be considered the relic species of earlier floras? What factors permitted or encouraged the inter-migration of Australian-Malaysian and Asiatic-Malaysian types and what were the limiting factors? Were these geological or climatic in nature, or both? Does the theory of continental shift throw any light on the problem? What are the relations between the present distribution of plants and the prevailing winds? What bearing do typhoons have on the problem? What is the relationship of existing ocean currents to the spread of plants? What does the annual north and south flight of certain types of migratory birds signify for those plants characterized by the production

of myriads of minute seeds and adapted to muddy or wet habitats? What are the effects of constantly moist and alternatingly wet and dry conditions? What is the effect of dominant mountains and mountain ranges on prevailing winds and *vice versa,* and how do these factors affect vegetation? What is the bearing of geologic history and of hydrography and topography on the problem?

From long residence in the tropics and from numerous observations made on the vegetation, some years ago I reached the general conclusion that in modern times man is the most important single factor in the dissemination of plants. Manifestly much of Malaysia was originally covered by a forest vegetation of one type or another. To-day vast areas are under intensive cultivation, almost equally large areas are in primitive cultivation, enormous tracts are covered with coarse grasses, bamboo thickets, and second growth forests. Man's agricultural activities have been the greatest single factor in the destruction of the original forests over vast areas, but lumbering, and in some regions mining, has played a part. It is axiomatic that in Malaysia a primary forest once destroyed is never re-established directly; its place is taken by coarse grasses, bamboo thickets, or dense stands of rapidly growing small trees and shrubs. As the primary vegetation has been destroyed the habitats have been provided for plants from other regions. These, accidentally or intentionally introduced by man, or through the agency of nature, once man has paved the way for them, have become dominant over great areas. Many of these were of American origin, introduced since the sixteenth century, including representation of such woody genera as *Leucæna, Psidium, Lantana, Pithecellobium* and *Prosopis,* and a very large number of weedy herbaceous plants in such genera as *Drymaria, Malachra, Waltheria, Stachytarpheta, Cassia, Hyptis, Ageratum, Cosmos, Elephantopus, Erechtites,* and *Synedrella,* as well as numerous grasses and sedges. Antedating these numerous American introductions were many Asiatic types, and this introduction of Old World forms is still progressing. There is much that needs to be done in reference to the history of these introduced plants. Where did they come from? When were they introduced, and how? What are the reasons for their present dominancy? What is the percentage of introduced species in primary forest areas as compared with the percentage in those regions where man is directly or indirectly responsible for the present vegetation?

Endemism presents numerous fascinating problems. Throughout Malaysia one finds in most of the large genera a few strongly characterized, widely distributed species. At the same time in these genera one notes that in such groups as *Ficus, Antidesma, Eugenia, Medinilla, Dendrobium, Quercus, Eria, Bulbophyllum, Calamus, Aglaia, Begonia, Polyalthia,* and *Canarium,* to mention only a few, that there is a tremendously

developed local endemism in many of the larger islands and even in some of the smaller ones. Invariably the percentage of endemics is very low in the settled areas, open grass lands, and secondary forests, and correspondingly is very high in those groups that require primary forest conditions. One concludes that the primary forests represent the original vegetation, and that the low percentage of endemics in the settled areas, open grass lands, and secondary forests is a reflection of the activities of man on the vegetation as a whole; that many of the species now dominant in these latter areas were introduced as the primary forests were destroyed. We are reasonably certain that this was the case in reference to the many species of American origin, which predominate in the settled areas, for these did not commence to come in until some time during the sixteenth century. We are less certain in reference to those species of Asiatic origin, largely groups characteristic of the second growth forests and open grass lands.

The cultivated plants represent a series of problems in themselves. Most of those in Malaysia are not natives of the archipelago but were introduced by man from other regions. The earliest invading peoples probably brought no plants for they had no agriculture. Later waves of more advanced peoples certainly brought cultivated plants with them. Many basic Malaysian food plants were introduced in prehistoric times, others in modern times; and the introduction of weeds parallels the introduction of economic species. Within the period of western expansion the Malaysian flora has been greatly enriched through the introduction of numerous economic plants and many weeds of American origin.

Not to be disassociated from the cultivated plants are their aboriginal names, which in many cases point definitely to the place of origin and the approximate time of introduction of individual species. In these fields of ethnobotany and comparative philology of plant names much needs to be done, and Malaysia with its very numerous dialects and its great racial mixtures offers a marvellously fertile field.

Again in the field of plant biology there are numerous problems. The relationships between insects and plants, birds and plants, and even bats and plants in reference to cross pollination. The biological relationships between ants and such domiciliary plants as *Hoya, Dischidia, Myrmeconauclea, Neonauclea, Macaranga, Lecanopteris, Polypodium, Dæmonorops, Myrmecodia, Hydnophytum, Myrmedoma, Saurauia,* and *Piper,* and representatives of other genera where plant organs such as branches, stems, leaves, and sheaths have been modified to form domiciles for colonies of ants. But this and numerous other subjects is outside the scope of this paper.

In this brief survey, hurriedly written because of the exigencies of my present situation, and entirely undocumented, I have attempted merely to enumerate some of the numerous intriguing problems of Malaysian phytogeography. I have done so in the hope that some who read it may be tempted to assist in solving some of the problems by undertaking field work in this too little explored part of the world or to co-operate in the study of the rich reference collections already available. In Malaysia one is constantly on the edge of the botanical unknown. The field is vast, existing problems create further ones, and the need of more investigators is great. The serious-minded interested student who elects to assist in the study of the plants and plant problems of Malaysia will be amply repaid by the productive results secured.

THE DISPERSAL OF PLANTS BY FRUIT-EATING BATS.

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Many data are at our disposal about the dispersal of plants by birds, both endozoically and exozoically. Very little, however, is known about the part played in plant dispersal by fruit-eating bats. They are probably as important as the birds, but exact observations are mostly lacking. In H. N. Ridley's well-known handbook on the "Dispersal of Plants throughout the World" three pages are filled with what is known of plant dispersal by bats. These data are based partly on his own observations made during his long and fruitful stay in the tropics, and partly they have been taken from literature. In the same work upwards of 130 pages are given to seed dispersal by birds.

Fruit-eating bats occur in the tropics of the old and of the new world, but they are most numerous in the tropical territories of Asia and Australia. Little is known about their way of living, though they can be observed everywhere. In the twilight these bats come forth from their sleeping places, just like the insect-eating species, and look for their food during the night, to turn back again to their sleeping places at day-break. A few species, *viz.* of the genus *Pteropus,* the Fox-bats, hang down from the branches of large trees, in great numbers together, during the daytime. Others hide themselves, resting in holes, or under folded leaves of palm-trees, or in dark parts of the forests, as I observed several times in Krakatau. In the lake-plains of northern New Guinea I saw large troops, consisting of thousands of individuals, flying low in great circles above the vast *Saccharum*-marshes, during the hottest hours of the day. The animals circled in a quiet, regular flight above the grass covering, and it seemed as if they were asleep. When they were startled by a gun-shot, they flew restlessly in all directions, finally to unite again into the rotary flight. Above these marshes this phenomenon seems to be observed regularly; in 1926 I myself saw it four times, and also during former expeditions it seems to have been perceived, for this place, which is a large island in the river Mamberano, has received the name of Kalong Island, *i.e.* island of flying foxes.

Sody[1] mentioned a few particulars about the modes of life of fruit-eating bats in captivity. These animals seem rarely to be kept in captivity, but Sody succeeded in keeping a female of

1. Sody. Iets over vruchtenetende vleermuizen in gevangenschap. De Tropische Natuur. Vol. XVII. 1928, p. 179.

Cynopterus sphinx tithœcheilus, and her young alive for a considerable time. According to him both specimens were hostile to approach. At Bandoeng, I myself kept a specimen of *Pteropus* species in my aviary for a long time; it was very affectionate, crept up my coat, and nestled its head against my neck. According to SODY they seek food late in the evening, take it along to the higher parts of the cage, and eat it while hanging down. Sometimes they hang down by one leg only, using the other to hold the fruit in front of them. In the field he observed that this species broke off the fruits of *Piper aduncum*. Unfortunately nothing is said about the food eaten by the animals in captivity, only that they got soft fruits. Nor are any data given about the digestion of fruits, and the excretion of seeds.

The fruit eating bats mainly live on fruits, but other parts of plants are eaten also. The fruits eaten by these animals are either soft or hard. Soft fruits which are taken may be berries, soft drupes, figs, and gourds. But they eat also fruits with a hard, or rather hard, fruit-shell. These are mainly the larger drupes. These are torn off with the beak, and brought back to the resting places, to which the animals return again and again. They usually choose a spot near the tree from which they gather the fruits, using a branch, roof-gutter, or prominent parts under the roofs or galleries of houses, to hang from. The soft or hard wall is partly or completely gnawed off from the kernel, and the latter is simply dropped. Often they seem to take the fruits along over greater stretches on returning at dawn to their sleeping places, for below them fruit-kernels and seedlings are often found. At Buitenzorg, near my laboratory, there stood a few old specimens of *Corypha Utan*, in which roosted a colony of *Cynopterus sphinx tithœcheilus*. The animals slept in the old, more or less folded and drooping leaves. Under these trees the grass was partly killed by the excreta, but a number of plants developed from the fruits taken home by the bats, and eaten there. They sometimes drop the fruits undamaged during the flight. During the time the large *Canarium commune* bore fruits in the Botanic Gardens, at Buitenzorg, we could often hear the heavy fruits banging down on a zinc pent-house.

These animals probably cannot cover great distances with these heavy fruits. Observations, however, are lacking, and it would indeed be very difficult to make any. But yet many fruits and plants which I found under the above-mentioned sleeping places at Buitenzorg, must have been carried for a distance of hundreds of metres, because in the immediate surroundings of the *Corypha* there were no fruit-bearing trees from which the bats could have taken their food. As the animals

are very voracious, and often eat only a part of the fruit-flesh, these large colonies must destroy enormous quantities of fruits. For the dispersal of fruits over moderate distances they must undoubtedly be of the greatest importance.

VAN DER PIJL[1] tells in an article of recent date that the fruit-flesh is not eaten straight away, but chewed, sucked, and ejected. These animals have a very narrow gullet, measuring in case of *Cynopterus* 2 to 2½ mm. And almost without exception, the intestinal canals of these animals are filled with a colourless jelly. The larger species of *Pteropus* too are said not to contain any seeds in the intestinal canals. MC. CANN[2] also found only a mucous fluid in the intestines of *Pteropus giganteus*, although the animals had eaten fruits of various species of *Ficus* only a short time before. VAN DER PIJL, however, mentions that seeds of *Ficus fistulosa* have been found in the newly evacuated excrement of a *Cynopterus sphinx*, and that the intestines of *Cynopterus brachyotis*, which had eaten the catkins of *Piper aduncum*, contained seeds of this plant.

According to VAN DER PIJL, fruits eaten by bats have certain characteristics, *viz.* inconspicuous colour, a smell which is neither fresh nor agreeable, large size, large kernels, hard flesh, while the part of the plants from which the fruits are taken is near open spaces. Such fruits are actually found in the food of bats, but many others, besides which are juicy, fragrant, small, and soft. At any rate, these animals are important because they eat many fruits which are despised by most fruit-eating birds.

Most remarkable is, according to VAN DER PIJL, the cauliflory of many fruits eaten by bats. He observed the following fruits eaten by bats: *Achras Zapota, Anona muricata, Averrhoa Carambola, Bouea macrophylla, Canarium* spec. div., *Carica Papaja, Ceiba pentandra, Cynometra cauliflora, Elæocarpus Ganitrus, Eugenia javanica, malaccensis,* and *polyantha, Ficus fistulosa,* and *glomerata, Garcinia Mangostana, Lansium domesticum, Mangifera cæsia, fœtida,* and *indica, Musa paradisiaca, Melia Azedarach, Nephelium lappaceum, Persea americana, Psidium Guajava, Phyllanthus acidus,* and *Emblica, Sechium edule, Spondias,* and *Zalacca edulis.*

In case of species of large fruits with large kernels only the wall is eaten away, but the soft fruits with small seeds are eaten either whole, or part of them. A great number of seeds are

1. L. VAN DER PIJL. Zaadverspreiding door vleermuizen. De Tropische Natuur, Vol. XXIV. 1935, p. 131.
2. MC. CANN. Notes on the flying fox (*Pteropus giganteus*). Journ. Bomb. Nat. Hist. Soc. Vol. XXXVII. (Quoted from VAN DER PIJL.).

eaten together with the flesh in which they are imbedded. In the case of figs they are really small fruits covering the inner wall of the receptaculum, but I will call them "seeds". The juicy fruits are digested in the intestinal canal, and the seeds come forth undamaged together with the excreta. These excreta are dropped, not only in the resting places, but also during the flight, so that the seeds can come down in all kinds of places. They are hardly ever found on the ground, because here they are hidden between plants, but often on leaves, stones, and walls. The excreta are of a very fluid consistency, often jelly-like. I often saw the seeds of *Piper aduncum* on leaves in the surroundings of Buitenzorg. I saw leaves with excreta containing seeds of *Ficus* in Krakatau, where there is a very great number of two species of fruit-eating bats, *Cynopterus Horsfieldii* and *C. sphinx tithæcheilus;* in the higher parts of the same island I found excreta principally containing seeds of *Cyrtandra sulcata*. The excreta also often come down on buildings, and young plants of *Ficus Benjamina* and of *F. retusa* can often be seen growing in the gutters. When the seeds come down on old, badly kept buildings, or on old temples, then the roots of these large species of Ficus can slowly break the stones asunder, and do much damage.

The animals need not rest while eating these juicy fruits, and thus the seeds can be carried over greater distances than in the case of big fruits with a hard kernel. It is not known how long a time the seeds need to pass through the intestinal canal of bats in the digestive process. It would be important to study this.

In the islands north of Batavia there are large colonies of *Pteropus,* and the animals fly over to the shore of Java, late in the afternoon, or early in the evening, in order to look for food. When at sea one can often see large groups of these animals crossing wide sea-arms. Undoubtedly these animals have played a part in the dispersal of seeds to the islands of the Krakatau-group. It is not known when these animals have arrived there. JACOBSON[1] who examined the fauna of these islands in 1908 fails to mention them, but in 1919 they were quite common, and DAMMERMAN[2] mentions them in 1922.

The first to write about plant dispersal by bats was RUMPHIUS, in his well-known Herbarium Amboinense. He mentions *Nauclea elegans, Artocarpus integra* and *communis,* besides *Anona mucosa,* and two species of *Mangifera,* the seeds of which are spread by bats. In addition many data can be found in the above mentioned work of RIDLEY.

1. E. R. JACOBSON. De nieuwe fauna van Krakatau. Jaarverslag van den Topographschen Dienst in Nederlandsch Indië over 1908. Batavia, 1909, p. 192.
2. K. W. DAMMERMAN. The fauna of Krakatau, Verlaten Island and Sebesy. Treubia, Vol. III. 1922, p. 65.

An examination of the contents of the intestinal canals of these animals might produce important results. Up till now only a few facts are known. One might also collect the fruits and seeds from the excreta. Another way of carrying out the investigations with a greater chance of success, is the observation of plants which regularly come up under the sleeping and resting places of these animals. During the many years which I stayed in Java, I noted down, here and there, which species of plants occurred in such places. In a few cases it was not possible to recognize the species of plant from the young, non-flowering materials. It appeared from these observations that numerous species of plants are spread by these bats; the appended list, undoubtedly, does not contain all the species which are actually eaten and dispersed. The list, moreover, shows that it is mainly species of trees from which the bats take their food. Yet one sees among them also smaller plants, such as *Clibadium surinamense*, *Passiflora fœtida*, a *Zingiberacea*, and an Aroid.

Some plants owe their quick dispersal mainly to these animals. *Piper aduncum* is a small tree which has been imported to the Botanic Gardens at Buitenzorg from tropical America. The trees, which are 2 to 6 m high, often bear large quantities of fruit-catkins, which are principally eaten by the smaller species of fruit-eating bats. Owing to this the plant has spread very quickly in the surroundings of Buitenzorg, and farther in West Java. Large quantities occur in grass jungles, in valleys, and in kampong wildernesses, where often it may crowd out the original flora.

Below is given a list of the species of plants which I have found. Most observations have been made in Buitenzorg, but also in Batavia, Bandoeng, Samarang, Cheribon, and other smaller places, wherever I had the opportunity. As I was not able to state the species of bats, I give the list without indicating them. Among the plants found in Buitenzorg there are several species of trees which are cultivated in the Botanic Gardens.

Young plants found under the resting and sleeping places of fruit-eating bats :—

MORACEÆ

1. Artocarpus communis FORST.
2. ,, elastica REINW. et BL.
3. ,, integra MERR.
4. Ficus ampelas BURM.
5. ,, Benjamina L.
6. ,, callosa WILLD.
7. ,, elastica ROXB.
8. ,, fistulosa REINW.
9. ,, fulva REINW.
10. ,, hispida L.
11. ,, infectoria ROXB.
12. ,, pilosa REINW.
13. ,, retusa L.
14. ,, septica BURM.
15. ,, variegata BL.

URTICACEÆ.

16. Pipturus incanus WEDD.

PIPERACEÆ.

17. Piper aduncum L.
18. ,, retrofractum VAHL.

EUPHORBIACEÆ.

19. Antidesma Bunius SPR.
20. Baccaurea racemosa M. A.

ANONACEÆ.

21. Anona muricata L.
22. Species ignota.

LAURACEÆ.

23. Litsea polyantha JUSS.
24. ,, species.

FLACOURTIACEÆ.

25. Flacourtia Rukam Z. et M.

PASSIFLORACEÆ.

26. Passiflora fœtida L.

CARICACEÆ.

27. Carica Papaja L.

GUTTIFERÆ.

28. Calophyllum Inophyllum L.
29. ,, species.
30. Ochrocarpus congregatus BOERL.

LEGUMINOSÆ.

31. Cynometra cauliflora L.
32. Maniltoa gemmipara SCHEFF.

MYRTACEÆ.

33. Eugenia aquea BURM. f.
34. ,, malaccensis LAM.
35. ,, polyantha WIGHT.
36. ,, species.

COMBRETACEÆ.

37. Terminalia Catappa L.
38. ,, species.

MELASTOMATACEÆ.

39. Melastoma malabathricum L.

MALVACEÆ.

40. Durio Zibethinus L.

ELÆOCARPACEÆ.

41. Elæocarpus species.

RUTACEÆ.

42. Evodia species.

BURSERACEÆ.

43. Canarium commune L.
44. ,, species.

MELIACEÆ.

45. Aglaja species.
46. Dysoxylum species.
47. Lansium domesticum CORR.
48. Melia Azedarach L.
49. Sandoricum Kœtjape MERR.

ANACARDIACEÆ.

50. Gluta Renghas L.
51. Mangifera indica L.
52. ,, species.
53. Spondias dulcis FORST.

SAPINDACEÆ.

54. Nephelium lappaceum L.
55. Sapindus Rarak DC.

EBENACEÆ.

56. Diospyros species.
57. ,, species.

LOGANIACEÆ.

58. Fagræa species.

RUBIACEÆ.

59. Morinda citrifolia L.

CUCURBITACEÆ.

60. Trichosanthes species.

COMPOSITÆ.

61. Clibadium surinamense L. var. asperum BAKER.

ZINGIBERACEÆ.

62. Amomum species.

MUSACEÆ.

63. Musa species.

PALMÆ.

64. Actinophlœas angustifolius BECC.
65. Arenga pinnata MERR.
66. Bactris speciosa KARST.
67. Caryota Rumphiana MART.
68. Corypha Utan LAMK.
69. Livistona rotundifolia MART.
70. Oncosperma filamentosa BL.

ARACEÆ.

71. Colocasia species.

OPEN AIR HOTHOUSES IN THE TROPICS AT 3100 METRES ALTITUDE.

By C. G. G. J. VAN STEENIS,
Botanist at the Herbarium, Buitenzorg, Java.

In this article I discuss the ecological and morphological reponse of some plant species to the action of fumaroles in the highlands of Java and Bali. I also discuss briefly the dispersal of some of these plants.

In June of this year I climbed Mt. Ardjoeno[1] in East Java. This lofty volcanic mountain complex, attaining more than 10,000 feet above sea level, is built upon a fault running north and south.[2] It consists of 5 separate peaks, the northernmost of which is called Mt. Welirang. Welirang is the Javanese name for sulphur, and this peak is so called because of the occurrence of several enormous solfatara, which have been commercialised for centuries, probably even in Hindu times. Numerous Hindu monuments are found on Mt. Ardjoeno at nearly 10,000 feet altitude in the form of remains of well built rooms. Even today on several Javan mountain peaks priests live a poor life and offerings are regularly made by the people.

The southernmost peak of the mountain complex is Mt. Ardjoeno itself in a restricted sense. This peak, the highest of all, is practically extinct. It does not possess such huge craters and solfatara as Welirang. Between Ardjoeno and Welirang there are three other peaks of lesser altitude. The southernmost and lowest is Mt. Bakal, a rough and rocky, extinct lava-stop. The two others are both called Kembar; we shall distinguish them as Kembar S. and Kembar N. Both are characterised by the occurrence of numerous fumaroles near their summits. They are reached easily along the road from Trètès to Lalidjiwo; in the latter place there is a resthouse at about 2500 m. altitude, situated within the pure *Casuarina Junghuhniana* forests, which cover the entire northern side of the mountain. From Lalidjiwo one reaches the pass between the Kembars, 2900 m. altitude, in about one hour and a half. Near the pass I observed the first small and hitherto unrecorded fumaroles in the northern of the two blowholes. The soil, consisting of weathered volcanic rock, is hot, and steam—which condenses immediately at this altitude—is continuously produced.

1 *Oe* in Dutch is pronounced as *ou* in *would*
2 Cf. N. J. M. Taverne, Vulkaanstudien op Java (Vulkan. Med. Ned. Ind. 7, 1926, p. 109, seq.)

It is a well known fact that the local distribution of mountain plants is often very curious. So for instance *Lycopodium clavatum*, L. and *Gaultheria fragrantissima*, Wall. have only been found on the Kembar peaks, but never on the much loftier Welirang or on Ardjoeno itself.

From the pass I climbed Kembar S., which is 3100 m. high, in about half an hour, over the gently sloping northern ridge, which is covered by a very short vegetation of small herbs such as *Styphelia pungens*, Koord., grasses such as *Danthonia pilosa*, R. Br., *Festuca nubigena*, Jungh., *Tripogon exiguus*, Buese, and especially *Imperata (lalang)*, and several orchids such as *Thelymitra javanica*, Bl., and *Microtis unifolia*, Rchb. Remains of charcoal from burned shrubs confirm our idea, derived from the occurrence of lalang, that the absence of forest is due to fire and to the grazing of deer. Deer are very common here, as shown by their numerous droppings, especially towards the summit. I had very bad weather, and made my way upwards first in a cold drizzle, then under heavy rain. Whereas all the slopes, except the ridge towards the pass, are covered by fairly tall tjemara forest, the top region proper is devoid of forest. It consists of a horseshoe-shaped ridge in the centre of which a so-called *sawahan* is situated, that is a cup-shaped basin covered entirely with the tuft grass *Festuca nubigena* Jungh. Everywhere on the summit steam escapes from cracks in the hot rock; the peak may be said to be more or less crowned by numerous steam clouds. It was a very agreeable sensation to sit on the hot soil within reach of the steam, which escapes under pressure with a dull droning sound. Less agreeable is the smell which is halfway between that of a rotten egg and that of a phalloid. However, no SO_2 was observed. The natives told me that deer came here at night to sleep.

A very peculiar vegetation is developed round these fumaroles, and it shows a distinct zonation. Some metres from the centre, where the steam loses its heat, *Lycopodiums* (*L. cernuum*. L. and *L. clavatum*, L.) thrive in a rather dense thicket along with *Gleichenia linearis*, Clarke and some poor tjemara, only one metre tall, densely clad with *Usnea*. Still nearer to the steam-holes the vegetation is much lower and consists of a carpet of very small herbs. Here *Lycopodium cernuum*, L. shows a very peculiar modification, becoming a flat plaited mat of hardly 1 dm. thickness, covering several square metres. It has just the appearance of a moss (Pl. 1). Other weeds are also able to approach the hot steam, namely a common lowland Rubiacea, *Oldenlandia herbacea*, L., which I was very astonished to find in such a peculiar locality, forming

a very low dense mat. Still other weeds show the stunted dwarf habit. These are *Fimbristylis capillaris*, A. Gray, and also, though less typical, *Lindernia crustacea*, F. v. M., *Senecio sonchifolius*, Moench, and a *Blumea*. All of them, however, do not form mats. Moreover, *Lindernia* and *Fimbristylis* are found elsewhere in Java in dwarf forms, notably on poor soil, *e.g.* on gravel round houses. It must be noted that *Lycopodium cernuum* and *Oldenlandia* are found thriving more luxuriantly some metres away from the steam spouts. Hence the **fumarole modification is effected by the tolerance of these plants.** All the plants mentioned live in continuously humid and warm surroundings, which I call an open-air hothouse in a temperate mountain zone. The wind often alters its direction and sways the steam clouds all over the summit ridge and on account of this several of the plants mentioned occur scattered amongst the lalang. In some places swollen semiglobular white cushions of the moss *Racomitrium* lie loosely on the hot wet rocks.

After I had made these observations I unexpectedly received confirmation of the phenomena described when my friend C. N. A. de Voogd, chief forester of Bali, etc., sent me a collection of plants from the Lesser Soenda Islands and gave me permission to publish concerning them. He collected in 1934 on Mt. Agoeng, the highest peak of Bali island, 3100 m. altitude. It is thus of the same height as Mt. Kembar. Agoeng also has fumaroles on the top ridge and there De Voogd collected some other plants which show the same steam habit as the Kembar plants. He too collected the stunted form of *Oldenlandia herbacea*, L. (Pl. 1) and also found some lowland plants in the Bali open air hothouse, *viz. Mitrasacme nudicaulis*, R. Br., *Bidens pilosus*, L. and *Senecio sonchifolius*, Moench. His best finds were, however, the steam-modifications of two species which I did not get on Kembar—of *Dicrocephala chrysanthemifolia*, DC. and of *Hyptis brevipes*, Poit., the former a mountain plant, the latter a typical lowland plant (Pl. 1). Mr. de Voogd informed me that the fumaroles of Mt. Agoeng also produce steam without any smell of SO_2. He camped on the summit ridge and his coolies pitched a tent above one of the fumaroles to keep warm. The condensation of the steam during the night, however, caused "rainfall" in the tent, so that this idea turned out to be less practical than it was ingenious.

It is definitely shown that steam, at least that of fumaroles at high altitudes in the tropics, has a very uniform effect on plants which are not in the least allied to one another. It is of interest to note, too, that the steam does not diminish fertility, as both *Oldenlandia* and *Fimbristylis* were in flower.

The sketches given above lead to another general consideration. The question arises how these lowland plants were dispersed to this high altitude. *Dicrocephala chrysanthemifolia* and *Lycopodium cernuum* are of general occurrence in the Javan high mountain zones, but what about *Oldenlandia* and the others? Of these common weeds (only *Mitrasacme nudicaulis* being decidedly rare) we have abundant herbarium material at Buitenzorg, and on the labels of most specimens the altitude is noted. From this material, collected throughout the Malaysian region, I made the following table of the greatest altitudes:—

In Malaysia from sealevel up to:	Malaysia	Kembar	Agoeng
Bidens pilosus, L. ...	c. 2100 m.	—	3100 m.
Hyptis brevipes, Poit. ...	c. 1200 m.	—	3100 m.
Lindernia crustacea, F. v. M.	c. 1450 m.	3100 m.	—
Mitrasacme nudicaulis, R. Br.	c. 1700 m.	—	3100 m.
Oldenlandia herbacea, L. ...	c. 1450 m.	3100 m.	3100 m.
Senecio sonchifolia, Moench.	c. 2000 m.	3100 m.	3100 m.

This table shows distinctly that there is a distinct gap between the common occurrence in the lowlands and the hills and that near the fumaroles on the mountain tops. This cannot be attributed to the absence of waste ground, where these pantropic weeds generally grow, in the mountains. On the contrary, waste ground is very common on the mountain slopes, where natives burn the vegetation, cut paths, build houses and try to cultivate crops such as maize and potatos. I am of the opinion that the plants concerned cannot stand the cold of the higher mountain zones above 2000 m. This would fit in with their occurrence in local hotter spots, such as the fumaroles.

The question of vertical dispersal still remains. In the case of the only Composite, *Senecio sonchifolius*, Moench., the pappus is no doubt responsible for dispersal by ascending winds, which, as I observed frequently, may be very strong. But the other plants do not possess any special means for wind dispersal. Neither their seeds or their fruits are fleshy and *endozoic dispersal* seems out of the question. **Exozoic dispersal must be held responsible.** Their seeds or fruits are all small and inconspicuous, as are the plants themselves. The only notes on their methods of dispersal that I could find in Ridley's well-known work "Dispersal of Plants throughout the World" are that *Lindernia* may possibly be dispersed by mud on birds' feet,

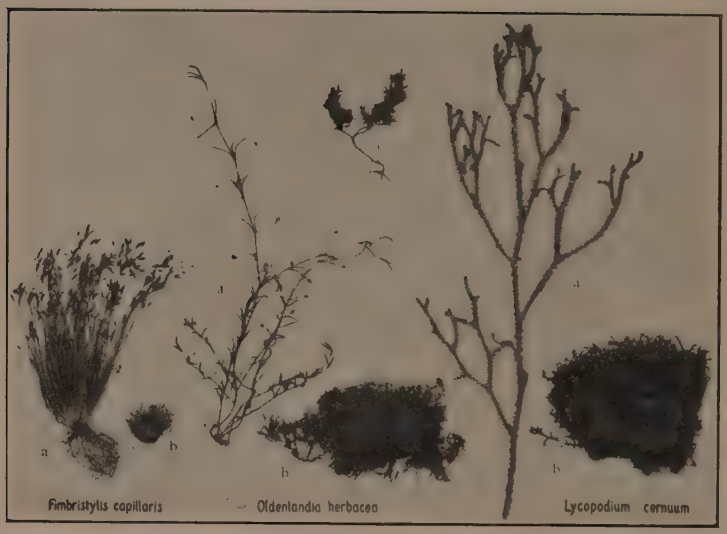
Oldenlandia washed away by rain, and that it might further be possible that the adhesive calyces of *Hyptis* and the pappus of *Senecio sonchifolius* and of *Bidens* could become entangled in the hair and feathers of animals.

I prefer to put forward the following hypothesis. It is common knowledge that deer migrate through the forests not only in a horizontal but also a vertical direction. Mr. W. H. de Kramer[1] wrote on migration of tiger, python, bear and pig during the fruiting season of the durian (*Durio*) in South Sumatra. The then prevailing western winds bring the smell of durian towards the interior, attracting the pig, and with the latter comes the whole fauna living on them. Migration of elephant and of rhinoceros from sea level to high up the mountains is well known. In January 1935, it was observed that on the north slope of Mt. Slamat in Central Java a continuous migration downwards of the fauna, including deer, was taking place. The natives attributed this to a future eruption, which the animals knew by instinct was coming.[2] That their instinct proved to be at fault does not matter here. It might be that the grazing on higher levels was poor at that time. It is a fact that several animals when old migrate to mountain tops to die in solitude, the reason for which is unknown. Several notes on this phenomenon have been published in our semi-popular naturalists' journal "De Tropische Natuur".[3] I may mention here of the animals found on high mountain tops—often dead—the flying squirrel (at 3675 m. on the summit of Mt. Smeru and at 3800 m. on the summit of Mt. Kerintji), the *kambing utan* (the Sumatran mountain goat) and a rat on the top of Mt. Kerintji, 3800 m., several birds, black monkeys (*Semnopithecus maûrus*) on Mt. Smeru and so on. It seems to me that exozoic dispersal by migrating animals, either ascending or descending for food supplies, for dying or for other reasons is the most reasonable explanation of the occurrence of lowland plants near fumaroles. The seeds may adhere with mud to hair or feathers, or, as seems more probable to me, to the hooves and feet of animals, and be occasionally dispersed in that way. They may adhere in no less degree to the master of all animals, man, who frequently visits mountain tops and may unintentionally carry with him seeds from lower down. I refer especially to the statement made above of priests living and people making offerings on mountain summits, a practice, which dates back to

1 De Tropische Natuur 23, 1934, p. 119-120.

2 Verslag Ned. Ind. Ver. tot Natuurbescherming 1933-1934, p. 33, 1935.

3 Cf. volumes 19, 1920, p. 197, and 20, 1931, p. 57.


a
b
b
a
b
Fimbristylis capillaris
Oldenlandia herbacea
Lycopodium cernuum

a
b
a
Hyptis brevipes
Dichrocephala
chrysamthemifolia

Hindu times. De Voogd informed me that the Balinese regularly make offerings on the summit of Mt. Agoeng, and that many monkeys live there, feeding partly on these offerings. These grey monkeys seem to be more or less accustomed to the presence of man, as they took small pieces of bread without hesitation. De Voogd also found a skeleton of a monkey on the summit of Mt. Agoeng.

The gap in altitudinal distribution I believe to be due to the fact that these plants are not able to thrive, or at least to settle, between the highest border of distribution and the abnormal high altitude of the fumaroles, of which the hot soil and atmosphere offer lowland conditions. It would be of great interest to make field experiments on this matter. It would be interesting, too, to make experiments in the laboratory to discover the physiological effect of steam on plants. I do not know of any such experiments. Can the tufted fumarole habit of plants be brought about artificially in the laboratory by the continuous action of pure steam? And in all plants? I much regret that I cannot give any exact data regarding the temperature of the fumarole steam. All I can say is that even near its point of escape it was quite bearable on the human skin.

Plate 1. Modifications of plants by fumaroles, the left figures of each species with the normal, the right with the abnormal habit. *Fimbristylis capillaris,* A. Gray, *a,* from Mt. Tengger, *b.* from Kembar S., x ¼; *Oldenlandia herbacea,* L., *a.* and *b.* from Kembar S., *c.* from Agoeng, x ¼; *Lycopodium cernuum,* L., *a.* and *b.* from Kembar S., x ½; *Hyptis brevipes,* Poit., *a.* from medium altitude, *b.* from Agoeng, x ½; *Dicrocephala chrysanthemifolia,* DC., *a.* and *b* from Agoeng, x ½.

SEMEIOCARDIUM ZOLL., A MISINTERPRETED GENUS OF BALSAMINACEÆ.

By C. A. Backer,

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In the Natuurkundig Tijdschrift voor Nederlandsch Indië XVII (1858–59), pp. 243 seq. the celebrated ichthyologist P. Bleeker published a letter, dated 8 August, 1858, written to him by the Swiss botanist-collector Heinrich Zollinger, then residing in the Dutch Indies, on the Natural History of Madura, a small island north of the eastern part of Java. In this letter Zollinger describes a trip made that year by him over the island in the company of N. A. Th. Arriëns, then Resident (*i.e.* Commissioner) of Madura. On page 245 of his description Zollinger says: "A new genus of the family of Balsaminaceæ "is perhaps the most important discovery. The plant grows on "naked calcareous rocks between 600 and 800 feet above sea "level and has entirely the structure of the common Balsams. "Instead of a spur one of the petals bears a short sack ending in "two obtuse points. The same petal" (this is an error; see description below) "is provided at its apex with a beautiful cordate "standard. On account of this character I have called the plant "*Semeiocardium arriensii*. To my regret I found only two ripe seeds which, however, did not germinate."

Here matters rested until J. K. Hasskarl in 1863 (Annales Musei Botanici Lugduno-Batavi, I, pp. 142 seq.) gave a monograph of Indian Polygalaceæ. He examined *i.a.* the type-specimen of *Semeiocardium arriensii* collected by Zollinger (No. 3956) bearing on its ticket the note: "corolla 4-color; vexillum cordatum, "cyaneum, albido-marginatum; saccus bifidus, luteus, purpureo-"maculatus". The flowers of Zollinger's specimen being clearly in a bad state of preservation Hasskarl not only could not find the sack or spur but moreover was led into the error of mistaking the plant for a Polygalacea. The genus Semeiocardium, of which he gave no diagnosis, was retained by him and he brought to it, besides *S. arriensii* Zoll., three species from British India. Of *S. arriensii* he gave a diagnosis, but his description of the inflorescences, flowers, fruits and seeds, apparently taken from another specimen, is entirely erroneous.

In Hooker's Flora of British India 1, 201 (1872) Alfred W. Bennett reduced the three Indian species of Semeiocardium to *Polygala triphylla* Ham., a plant which does not occur in Java, nor in Madura. He did not mention *Semeiocardium arriensii*.

R. Chodat in his *Monographia Polygalacearum*, 2me partie (Mémoires de la Société de Physique et d'Histoire Naturelle de Genève XXXI, Seconde Partie, 1892/93, p. 41), apparently not

having seen good specimens of *Semeiocardium arriensii* considered Semeiocardium to be a section of Polygala. To this section he reckoned, besides *Polygala triphylla* Ham., only the insufficiently known *P. cardiocarpa* Kurz. *Semeiocardium arriensii* Zoll. was reduced by him to *Polygala triphylla*.

I myself, having seen only very bad materials, committed the same mistake in my *Schoolflora voor Java* (1911), p. 77.

But in 1915 I had, thanks to Dr. J. C. Koningsberger, then Director of the Buitenzorg Botanical Gardens and an ardent promotor of the floristic investigation of Java and surrounding islands, the occasion of making a botanical trip to Madura. On this trip I had the good fortune to re-discover the plant evidently meant by Zollinger, who was, after all, much too able a botanist to mistake a Balsaminacea for a Polygalacea. The plant, which showed the characters mentioned by Zollinger in his short description, and which grew indeed on calcareous rocks, proved to be a true Balsaminacea, nearly related to Impatiens but differing from this genus (*see* below) by the 2 lateral and the 2 posticous petals being all of them connate into a rather large, bifid standard, and by the 4-celled (not 5-celled) ovary. In 1919 a slightly differing form of the same species was discovered by me in the Kangean Archipelago (east of Madura). I succeeded in bringing over living plants and seeds to the Buitenzorg Botanical Gardens. The seeds germinated poorly, but seeds thrown out by cultivated plants germinated now and then, always on rocks. In 1930 plants, offspring of those raised from seeds collected in Kangean, were still living in the Buitenzorg Gardens.

I give below a description of the genus and the species, based on living plants.

SEMEIOCARDIUM Zoll. (descriptio emendata).

Cymæ axillares paucifloræ. Flores more generis Impatientis resupinati, zygomorphi, bisexuales, majusculi. Sepala 3; duo lateralia alte connata, tenuiter membranacea; tertium posticum (antrorsum versum) majus, petaloideum, cymbiformi-infundibuliforme, breviter calcaratum; calcare disticte bilobo, antrorsum spectante. Petalum anticum (retrorsum vergens) liberum; duo lateralia quam cetera minora, fere ad apicem usque connata cum unguibus posticorum (specie anticorum); laminæ petalorum posticorum connatæ in vexillum antrorsum vel deorsum spectans, incisurâ angustâ fere ad medium usque bifidum; hisce 4 petalis connatis floris labium inferius biunguiculatum fingentibus. Stamina 5; filamentis liberis, brevibus, latis, ovarium celantibus; antheris crassis, in tubum brevem connatis; loculis apice poro magno dehiscentibus. Ovarium oblongum, 4-loculare; loculis pauciovulatis. Stylus 1, brevis, subulatus; capsula lineari-oblonga, 1-5-sperma; valvulis 4 elastice dissilientibus, semina ejaculantibus. Folia alterna, longiter petiolata, ovato-lanceolata, leviter serrata. Herba annua, erecta, patule ramosa; caule valde succulento; radicibus brevibus.

Genus Impatienti proximum sed bene diversum petalis 4 superioribus (specie inferioribus) in laminam bifidam, biunguiculatam connatis, necnon ovario 4-loculari.

Species adhuc unica :

Semeiocardium arriensii Zoll. (*see* the plate).

Cymæ breviter pedunculatæ, 1-3-floræ; pedicellis 10-16 mm. longis. Sepala lateralia oblique deorsum spectantia, mucronulata, pallide viridia, 10-18 mm. longa, 7-11 mm. lata. Sepalum posticum a lateralibus partim tectum, mucronulatum, album vel pallide flavum, intus pulchre rubro-striatum et rubro-guttatum. Calcar inter sepala lateralia occultum, 3-7 mm. longum, latum, basi et apice angustatum, petalum anticum ovali-ellipticum, 7-11 mm. longum, 6-9 mm. latum, viride, dorso carinatum; carina acumine recurvo terminata. Petala lateralia quam postica multo breviora; ungues petalorum posticorum curvati; labium (a petalis lateralibus et posticis formatum) late ovale, 15-20 mm. longum, in speciminibus madurensibus pallide violaceum, infra incisuram cum macula intense violacea, basi sæpe notatum punctis rubris quasi continuationem efformantibus punctorum striarumque sepali postici (unde error zollingerianum), in speciminibus kangeanensibus candidum, basi luteum. Tubus antherarum recurvum (specie procurvum). Ovarium glabrum. Capsula glabra, ± 20 mm. longa, 5-6 mm. lata. Caulis crassus, apice pubescens, deorsum glaber. Petioli 10-70 mm. longi; foliis ovato-oblongis, basi obtuso-rotundatis, apice acute acuminatis, leviter serratis, junioribus subpubescentibus, adultis glabris. Herba erecta, annua, 40-80 cm. alta.

Crescit præcipue in rupibus calcareis.

Distributio:—Madura (Backer 20268, 20911).

Archipelago Kangeanensis (Kangean et Paliat) (Backer 26962, 27376, 27409, 27863, 27950, 29565, 29966, 30004).

Semeiocardium arriensii Zoll. — Photo made in 1917 after a specimen cultivated in the Buitenzorg Botanic Gardens, raised from seeds collected in Madura.

THE FLOWERING OF TEMBUSU TREES (FAGRÆA FRAGRANS *Roxb.*) IN SINGAPORE, 1928—1935.

By R. E. Holttum.

The gregarious flowering of the Tembusu trees (*Fagræa fragrans* Roxb., or *Cyrtophyllum fragrans* DC) which are so abundant, both wild and planted, in the neighbourhood of the town, is one of the most striking seasonal phenomena to be observed in Singapore. Beautiful at all times, with their finely moulded masses of foliage, at the flowering season the trees are transformed by their host of small creamy-white fragrant blossoms. For a fortnight or more, some of the suburbs of the town are filled with their heavy fragrance, both day and night. This impressive spectacle occurs nearly always in April or May (usually May), and is followed in August by the almost equally impressive general fruiting of the trees, accompanied by nightly visits of hordes of giant fruit-bats. The whole phenomenon is one of the most regular features of the somewhat irregular general behaviour of plant life in Singapore. It is fairly certain that such a general flowering, as in other similar cases, is a response to some definite climatic change, and the question naturally arises what such a change could be.

In the Gardens Bulletin S.S. Vol. V, pp. 173-206, I gave an account of my observations on periodic leaf-change and flowering in Singapore, chiefly as regards deciduous trees, during the years 1927-1930. In the introductory part of that paper is a short account of the salient features of the climate of Singapore, and to this the reader is referred for further details. The distribution of rainfall throughout the year, though on the average very even, is so irregular in detail, and the incidence of dry weather so uncertain, that many species of plants which are native of seasonal climates behave quite abnormally. As regards the native evergreen trees, it appears that any pronounced dry spell will cause most of them to flower, provided they have had an appropriate period in which to recover after the previous flowering and fruiting season. Some trees respond very quickly to the dry weather, and flower within two or three weeks; others take much longer to develop their flowers. It is fairly clear however that most of them are dependent on pronounced dry spells, and that their flowering is much less regular than that of the Tembusu.

We have therefore to look for a seasonal phenomenon, perhaps relatively slight and not always effective on most trees, which is as regular as the flowering of the Tembusu. The one almost regular feature of our climate is the rather sudden break in the wet weather which usually comes some time in January. The wet season, which is most intense in November and December, is characterised by cloudy skies, prolonged slight drizzling

rains, and a very high general atmospheric humidity, with little bright sunshine and no drying winds. The actual rainfall may not be very heavy, but it has a far greater effect than at other times of the year, when heavy showers, followed by bright sunshine, are the rule. Then rather suddenly, usually in January, the cloudy weather ceases, and there is a shorter or longer period of drying winds. This drier weather may not last very long, but its onset, after the rather depressing wet season, is very noticeable.

The thought therefore occurred to me that perhaps the Tembusu trees are very sensitive to this change from prolonged wet to drier conditions, responding even though the dry weather is not sufficiently intense to affect some other trees. I have examined the rainfall records made at the Botanic Gardens during the period of my observation on the trees, and believe that they indicate a definite relationship between the change of season and the onset of flowering of the Tembusu. The irregularities of one are followed by irregularities of the other, and the last wet season, by stopping at an unusually early date, gave a most instructive example. Unfortunately the figures showing change of rainfall do not give a complete account of the climatic changes; the actual change, as above remarked, is accentuated by the presence of clearer skies and drying winds. The figures given are however perhaps enough to demonstrate a connection between the phenomena concerned.

The Tembusu tree is slow in all its activities. Its growth is slow, but seems to be an almost continuous process, unlike that of most evergreen trees, which produce new flushes of leaves at intervals of a few months (or sometimes many months). The development of flower buds is slow; though the flowers are quite small, the buds take something like two months from the time they are first visible to the opening of the flowers. The inflorescences are borne in the axils of quite young leaves; at flowering, the subtending leaves are usually the second pair from the apex of the shoot. Then the fruits, though small, take more than three months to ripen (it is usually about three and a half months from the height of the flowering to the full ripening of the fruit crop). These slow processes are perhaps connected with the soil conditions favoured by the trees, which grow best in the very hard compacted soil formed as a result of exposure to rain and sun. Under such conditions very few other trees will thrive. The soil is very slightly pervious to water and air. I have seen tembusu trees in the neighbourhood of Palembang (Sumatra) growing in swampy ground, and they also grow under similar conditions in Pahang; possibly the lack of aeration is the chief character in common between the swamp conditions and the compacted clay of Singapore. It is notable that the palms Oncosperma and Cyrtostachys, both native of wet ground, also flourish in hard clay soils suitable to the Tembusu.

In addition to the heavy flowering which is usual in May, the trees often have a subsidiary flowering towards the end of the year, in October or November, and occasionally a few flowers may be seen at other times. I have noted particularly the behaviour of three individual Tembusu trees from the latter part of 1927 up to the present (the observations are not quite complete, especially as regards the subsidiary flowerings, which are often not easy to observe). I have also noted the seasons of principal flowering of the trees in Singapore generally, and any pronounced subsidiary seasons. The main flowerings are therefore all noted, but not all subsidiary flowerings. Of the three individual trees, one stands almost alone, and has its lower branches intact and widely spreading over the ground all around it; the others are near other trees, one on a hill and the other in a more sheltered position near the bottom of a slope. They are referred to as E, X and P respectively.

The exact date of the beginning of flowering is not easy to fix; I have therefore indicated a date at which a general flowering was well in progress, perhaps a week after the first flowers open. As regards subsidiary flowerings, they are so incompletely recorded that I only quote here a few cases when the flowering was fairly general, or when one of the trees had rather numerous flowers at an unusual time.

I have indicated below the dates at which wet weather ceased, giving rainfall for the previous ten days, and for the week or more of dry weather following. It will be seen that general flowering is in progress about four months after the onset of the dry weather. To test whether the flowering dates could be connected with the length of the dry period, or with the time at which wet weather followed the dry, I examined the subsequent rainfall figures, but the incidence of subsequent rainfall and its amount are so variable that it appears most unlikely that it can have any effect on the time of flowering. As regards sudden dry weather following wet at other times of the year, this is rarely so pronounced as in January, as heavy rainfall at other seasons is usually of the heavy shower type; figures of relative humidity and perhaps of duration of sunshine would also have to be added to give a full account of the climatic conditions. However, I have traced some of the more pronounced subsidiary flowerings to dry weather following heavy rain, and these are indicated.

As the time from the stimulus to flower-development to the ripening of fruit is about seven months and a half, and as it is unlikely that further stimuli during that period could cause anything in the nature of a second general flowering, it is most unlikely that two full flowerings could occur in any calendar year; a second flowering would always be a subsidiary one, and probably affects those trees or branches which have for some reason not been affected by the main flowering. Flowering on

separate branches is a not uncommon phenomenon on trees of various kinds in Singapore; also leaf-change on one branch at a time.

In connection with the following figures, it may be noted that the average rainfall of the wettest month in the year (December) is about 12 inches, while May and June, which on the average are the driest months, have about 6 inches each; but the rainfall in any one calendar month varies considerably from year to year.

PRINCIPAL FLOWERINGS.

1928

Rainfall January 5–14 7.99 inches
15–21 .14
Flowering: May 12

1929

Rainfall December 28 (1928)—January 6 5.62 inches
January 7–13 .15
Flowering: May 5.

1930

Rainfall January 3–16 4.01 inches
17–26 .07
Flowering: May 20

1931

Rainfall January 15–22 5.22 inches (Jan. 12–14, 4.28 ins.)
January 25–February 2 .24 inches
Flowering: middle of May.

1932

Rainfall December 21–30 (1931)
December 31–January 5 .07
Flowering: May 1.

1933

Rainfall January 16–25 4.19 inches
January 26—February 1 .04
Flowering: May 27.

1934

Rainfall December 17–26 (1933) 3.81 inches
27–January 2 .00
Rainfall January 12–21 8.55
22–Feb. 3 " .00
Flowering: April 25–June 10.

NOTE:—The duration of flowering was recorded by Mr. Corner, and he did not note whether the main flowering began on April 25th. As a heavy flowering usually lasts for at least three weeks, two flowerings, one caused by dry weather

beginning December 27, and the other January 22, would produce the effect of a continuous flowering. The dry period December 27–January 2 was followed by more heavy rain, and then a more intense dry period, which evidently caused a second flowering.

1935

Rainfall November 28–December 7 (1934) 3.44 inches
December 8–27 .07

Flowering: April 7.

SUBSIDIARY FLOWERINGS.

1928

Rainfall September 30–October 9 (1927) 6.33 inches
October 10–21 .12

Small flowering on trees E & X, 19 February 1928.

Rainfall July 3–12 4.89 inches
13–30 .12

Small flowering on trees E & P, also general small flowering about November 11.

1929

Rainfall June 19–28 6.24 inches
26–July 12 .02

Small general flowering October 27.

1930

Rainfall November 26–December 5 (1929) 3.68 inches
December 6–15 .20

Tree X with many flowers on low branch, and tree P with some flowers, April 20 and 26.

Rainfall June 13–22 8.62 inches
23–July 5 .00

October flowering not noted, but tree E had many fruits ripening early in February 1931.

1931

Rainfall June 2–11 4.34 inches
12–20 .11

Tree X fairly full flowering in October.

1933

Rainfall November 30–December 9 (1932) 3.29 inches
December 10–19 .17

Small general flowering April 16, 1933.

1934

Rainfall July 16–27 6.95 inches
28–August 16 .38

Many trees have small flowering in early December.

1935

Rainfall December 30 (1934)–January 8 7.56 inches
January 9–13 .00

General small flowering, May 16.

The year 1935 was particularly interesting for two reasons. In the first place, the general flowering was a full month earlier than usual, following upon a most unexpected break in the wet season in the second week of December. In the second place, there was a quite well-marked second small flowering considerably more than a month after the first, and this corresponded to a second and more severe onset of dry weather, following much rain in the latter part of December and early January.

The above information needs to be supplemented by more detailed observations of the vegetative growth of Tembusu trees. What is required is regular measurement of the growth of all parts of a small branch, and also of the development of the inflorescence. It would be interesting also to make careful record of subsidiary flowering on a few individual branches, to find the minimum interval between two flowerings on the same twig.

It is quite likely that some other trees respond to the change of season in a similar manner to the Tembusu; but the only records I possess are of a much less regular nature. *Fagræa auriculata*, for example, sometimes flowers with the Tembusu and sometimes a full month later. The common scorpion orchid, *Arachnis flos-æris*, though flowering very regularly about May and November, does not appear to follow the fluctuations of the Tembusu. *Saraca laipingensis* and *Cinnamomum iners*, both of which flower gregariously not long after the change of season, are evidently more rapid in their response, and probably do not react to quite the same stimulus as the Tembusu, for I can find no relation between their flowering dates. Possibly some of the common species of *Eugenia* and *Elæocarpus* may have a similar response, but insufficient records of these are available.

SUMMARY.

In Singapore there is an almost regular general heavy flowering of trees of *Fagræa fragrans* Roxb. in May. This flowering is shown to follow about four months after the break in the wet season which usually occurs some time in January. Observations of rainfall for ten days before the break in the weather, and for a week or more afterwards, are given; the fluctuations of date of this break are followed closely by fluctuations in the date of the general flowering of Cyrtophyllum trees.

THE SEASONAL FRUITING OF AGARICS IN MALAYA.

By E. J. H. Corner,

Singapore Botanic Gardens.

There is no day in Malaya when the fruit-body of some agaric cannot be found in the high forest, but twice each year, in the south at least, there is a season of three months when a "run of fungus" develops like the autumn crop in temperate countries. Fruit-bodies, never seen at other times, then appear in great numbers with a succession of early, mid- and late seasonal forms. The forest may be so full of toadstools of all sizes, shapes and colours, in troops on the ground and on fallen wood and in myriads on dead leaves and sticks, that one cannot step without treading on them, and each kind has its season of but a few days or a week when it is in full fruit.

I learnt of these seasons first in the Gardens Jungle, over the few acres of which I searched almost daily in the year 1929, and then from repeated collecting in the forests of Singapore and south Johore and from occasional visits to more distant parts of the country. In the Gardens Jungle, also, I set myself to discover the exact times of inception of fruit-bodies and their periods of development and maturity so that I could determine the life of different kinds of fruit-body and the climatic stimulus to which their mycelia responded. I have collected much information on nearly a hundred species but only a few general facts can be mentioned in this place.

The Seasons.

In Singapore the first toadstool-season of the year extends from March to May and the second, less regularly, from some time in August or September, rarely October, to October or the beginning of December. From 1929 till the beginning of this year Boleti, for instance, fruited chiefly in March and August or September; *Hygrophorus firmus* B. and Br. fruited in April and October or November; *Amanita virginea* Mass. in May and November or the beginning of December. The lowlands of south Johore appear to have the same seasons though the dates may differ by two or three weeks through local variations in the weather. At Tembeling, in the centre of Pahang, a run of fungus was in mid-course at the beginning of November 1930, and one had just ended at the beginning of June 1931. On Fraser's Hill, at 4000′ in Pahang, a run had just ended in the middle of November 1930 and 1932. About 20 miles inland from Chukai, Kemaman, there was no run of fungus at the end of June 1932, though the forest was very wet. In Penang a run was starting at the beginning of March 1929. These dates agree with the seasons in Singapore. But in Perlis, in the north, a run was starting at the end of November 1929: at Slim River, Perak, and

on Fraser's Hill, Pahang, a run was starting at the beginning of May 1930: round Kuala Pilah and on the lower slopes of Gunong Angsi, in Negri Sembilan, a run was starting in the last week of June 1930: at Cameron Highlands, at 5000′ in Pahang, a run was finishing at the beginning of August 1934. These dates disagree, yet one may be certain that, while there is a seasonal fruiting in all parts of Malaya following changes in the weather, the date of the season in each place depends on local conditions, for the times of the weather-changes vary considerably not only in the lowlands but from mountain to mountain.

The Succession.

Without a systematic account of malayan agarics, only an outline of the seasonal succession can be given. Briefly it has this order:—

1st Crop:—epiphyllous species of Marasmius, Androsaceus, Mycena, Collybia, etc. with small fruit-bodies: some horse-hair Marasmius: Coprinus, Psathyrella and Leucocoprinus.

2nd Crop:—developing 4–8 days after the first: most kinds with large fruit-bodies but especially Amanita, Amanitopsis, Lepiota, *Collybia radicata*, Laccaria, Lactarius, Russula, Volvaria, Pluteus, Clitopilus, Leptonia, Inocybe, Astrosporina, Cortinarius, *Hypholoma janus* (B. and Br.) Petch, *Psathyra trechispora* Petch, Psaliota, Boletus, *Paxillus, Lentinus giganteus* B.

3rd Crop:—about two weeks after the second: Hygrophorus, Cantharellus, Pleurotus, Entoloma, *Clitopilus flavidus* Mass. (really an Entoloma), *Lentinus connatus, L. blepharodes, L. hookerianus, L. similis,* and other horse-hair Marasmius.

4th Crop:—about two weeks after the third: *Hygrophorus firmus* B. and Br. and several miscellaneous species.

5th Crop:—about 2–4 weeks after the fourth: *Amanita virginea* Mass. and many species of Hygrophorus and Marasmius.

The crops are not actually distinct but peaks, rather, on a summation curve in which the number of species fruiting in a locality and the number of fruit-bodies would be plotted against time, and with fewer, less conspicuous species fruiting in the intervals. The succession is so constant under normal conditions that a few easily recognisable species serve as indicators:—

Crop.		*Indicator.*
1st	...	Epiphyllous Androsaceus'' and Filoboletus (=Poromycena)
2nd	...	Amanita, Russula, Boletus in great variety
3rd	...	*Clitopilus flavidus* Mass.
4th	...	*Hygrophorus firmus* B. and Br.
5th	...	*Amanita virginea* Mass.

Amanita virginea, like *Collybia velutipes* in England, signifies the end of the season.

The Cause of the Seasons.

In most of Malaya rain falls so frequently that the forest is nearly always damp. A week without rain scarcely affects the humus. But twice each year, after the wet weather of November and December and April to June or July, there comes a spell of several weeks with sunny, windy days and only occasional showers. The forest then dries; the humus becomes friable and brittle; streams shrink in their beds; and the leeches disappear. Mycelial growth in the soil gradually stops and the hyphæ remain dormant for a week or more. At the next rains the hyphæ revive and fruit. Thus spring the first two crops of toadstools which begin the succession.

It may be thought, now, especially from the evidence of fungi grown in culture, that a mycelium would fruit so soon as it had gathered enough food, but I am convinced direct fruiting is exceptional among forest fungi and pertains more to species of transient or confined habitats, like coprophytes and carbonicolous forms. This succession in the rain-forest shows that most forest-species need an external stimulus to fruit, which is primarily the check to vegetative growth given by mild drought. For, two or three days after the forest floor is soaked again, fine rhizomorphs begin to grow in the humus and there is the mouldy smell of active mycelium. A few days later the primordia of Russules, Boleti and Amanitas appear and these, I find, take only 8–10 days to mature. There is, therefore, no time between the onset of the rain and the fruiting for vegetative growth. Indeed, the first mycelial growths of these fungi after the soaking of the soil are slender rhizomorphs—somatic strands, not diffuse feeding hyphæ.

The relation between the dry weather, the onset of the rain and the crops of Boleti in the Gardens Jungle is shown in the following table. The period of the dry weather is taken from the daily rainfall record in the Botanic Gardens and measured from the end of continually wet weather to the heavy rain which caused the resumption of mycelial growth in the soil. Actually it is an interrupted period of dry rather than wet weather, and single storms and light rain on a few successive days I have reckoned in the dry weather because I found, by carefully digging in the humus where toadstools always grew, that such rain never penetrated or lasted long enough to evoke the development of primordia. By digging in the humus after each likely storm toward the end of the dry weather, I determined to a few days when mycelial growth was resumed.

Year	*Dry Weather*	*Rain begins*	*Mature Boletus-crop*
1929	7th Jan.–8th March	9th March	24th March
	29th June–23rd Aug.	24th Aug.	10th Sept.
1930	20th Jan.–6th March	7th March	22nd March
	23rd June–6th Sept.	6–14th Sept.	24th Sept.
	15–27th Sept.	28th Sept.	16th Oct.
1931	26th Jan.–28th Feb.	1st March	18th March
	10th June–18th July	19th July	7th Aug.
1932	1st –18th Jan.	19–26th Jan.	8th Feb. (small fruiting)
	27th Jan.–16th Feb.	17th Feb.	6th March (heavy fruiting)
	10th July–2nd Sept.	3rd Sept.	20th Sept.
1933	26th Jan.–23rd Feb.	24th Feb.	14th March
	No record in second half of year		
1934	20th Jan.–27th Feb.	28th Feb.	20th March
	4th Sept.–8th Oct.	9th Oct.	27th Oct.
1935	6–25th Dec. 1934	26th Dec. 1934 –21st Jan.	20th Jan.
	22nd Jan.–12th Feb.	13th Feb.	6th March
	9th July–9th Aug.	10th Aug.	31st Aug.

Two crops of toadstools immediately follow the rain because the fruit-bodies of the epiphyllous species of the first crop are small and develop more quickly than the larger ones of the second and, moreover, growing on the surface of the humus, their mycelia revive sooner than the more deeply situated and, perhaps, mycorhizal mycelia of the second crop.

The toadstools of the third crop, which mature about 4–5 weeks after the wet weather has returned, may need to vegetate before fruiting or they may be delayed merely because their mycelia recover more slowly or take longer to develop rhizomorphs than those of the early crops: in general, their primordia develop at the same rate as those of Boleti. The toadstools of the fourth and fifth crops must have a preliminary vegetative stage yet they do not fruit indiscriminately as shown by their constant sequence.

Heavy rain must follow the dry weather to revive the mycelia but rain in itself is no stimulus to fruit. In June and December, when the forest is wettest and mycelia have been growing during several months of rainy weather, fruit-bodies are scarce. Toadstools of the second crop, which fruit about August, do not fruit in December though they have been vegetating for four months.

Many epiphytic orchids, it is well known, flower after a heavy storm not because of the wetting but because of the sudden drop in temperature during the storm. There is no evidence, however, that agarics respond to this stimulus. The drop in temperature must be appreciably less, both in degree and severity, in the humus than on the boughs of trees and, were the stimulus effective, runs of toadstools would be as frequent as the flowering of pigeon-orchids (*Dendrobium crumenatum*). I have, moreover, grown lignicolous agarics in a cool frame, where the temperature varied very gradually from 73–78° F. daily, and found that by drying the logs for two weeks and then soaking them fruit-bodies would develop without any marked change in temperature. And it seems that, except the highest mountain tops, nowhere in Malaya is the temperature low enough to limit the fruiting or the distribution of toadstools. All the common lowland species occur in the mountains at 4000–5000′, where the soil-temperature in the forest is, on the average 60–70° F. and 10–15° below that in the plains.

Some of these agarics, especially the Russules, Boleti and Amanitas, must be mycorhizal. In forests which I have repeatedly visited they occur season after season in the same places under the same trees, among which dipterocarps, oaks and Castanopsis are prevalent, and not elsewhere. They should fruit, one might imagine, according to some general activity of their host yet, as they do so at the same time or in sequence with saprophytic species, their mycelia must react like the saprophytic. Most forest trees respond to one or both dry spells of the year by flowering or leafing so that a run of fungus coincides with a flowering season, but without exact knowledge of the habits of the trees or of their mycorhizal fungi the ways of the two cannot be related. A remarkable Russule, for instance, I found in fruit in the mid-weeks of April and October in 1930, 1931 and 1932 only in one small area, about 30 yards across, on the lower slopes of Gunong Panti in Johore; it is clearly a seasonal, mycorhizal species, but its host cannot be determined by inspection for some twenty kinds of tall tree grow in proximity.

The Shortness of each Season.

During a normal year in Singapore and, probably, in any one locality in Malaya, Boleti will fruit for two weeks, the first in March, the second about September, and a botanist visiting the forest at other times could have no inkling of their existence

apart from a few species which fruit sporadically. (I have collected about 60 species without particular search). So, too, with other forest agarics: their seasons are remarkably short. Unless one can visit the forest at least once a week during a run of fungi many species, if not an entire crop, may be missed not merely because each has its place in the succession but because the fruit-bodies develop rapidly, especially through the later stages of expansion when they emerge from the humus, and they are short-lived. Those of Boleti, Paxillus, Flammula, Inocybe and Hygrophorus last about 4–5 days at maturity; those of Entoloma, Cortinarius and Lentinus may last a week or ten days; those of Amanita, Lepiota, Collybia, Russula, Lactarius, Volvaria, Psaliota and Psathyra last only 2–3 days: though there are a few exceptions such as two Boleti which I find last nearly three weeks.

When Patouillard came to Singapore on August 21st 1917 (Journ. Straits Branch R.A. Soc. no. 78, p. 67), there was a Boletus season in the Gardens Jungle and he described sixteen new species, though only seven had not already been collected by Ridley and Burkill in the same place and described by Massee (Kew Bull. 1901, 1909, 1914). But it could never have befallen Westerdijk that he went into the forest during a toadstool-season, when he wrote of the malayan region "In the virgin woods.....even the flora of mushrooms on the ground .....is absent. Everything seems to point to the conclusion that conditions are unfavourable to fungus growth" (Ann. Miss. Bot. Gard. 1915, 2, 308).

Irregularities in the Seasons.

A run of toadstools in the forest in a sure sign of a climatic change. The weather must have been dry enough to have affected the humus and the ensuing rain heavy and prolonged enough to have soaked it. A dry week might stimulate trees to flower or change their leaves and a storm might cause the pigeon-orchid to flower but the effects of such would not penetrate the dense canopy of the forest. Nevertheless there are minor irregularites in the toadstool-crops, which appear to be caused more by topographical features than climatic. A small, isolated and deteriorated patch of forest, such as the Gardens Jungle or the Bukit Timah Forest Reserve in Singapore, is exposed and a short dry spell or single storm might affect the humus; the wind could blow through such forest and dry the soil in weather which would not affect the continuous virgin forest. Thus I have noticed that there may be two crops of Boleti at the beginning of a season. In the Gardens Jungle in 1930, after a dry July and August, a great many Boleti began to develop about the 16th Sept., following a rainstorm on the 6th with showery weather in the ensuing week. But from the 15–27th the weather turned dry and windy and the floor of the jungle soon dried out; most primordia shrivelled and only a very few

came to maturity. Rainy weather followed from the 27th, with a heavy storm on the 28th, and the normal run of fungi began in October with a second, rather feeble, crop of Boleti about 16th October. It is unlikely that the rain from the 6–14th September would have soaked the humus in virgin forest or, if sufficient, that the following dry spell would have checked the new growth of mycelia, and there would thus have been the one normal succession. For the same reason there were two crops of Boleti at the beginning of 1932 and 1935; and the first crop of 1935 was exceptionally early because the wet weather broke a month before usual. In each of these instances only the first two crops of the succession were repeated; presumably the dry weather which returned after the first heavy rain prevented the mycelia of species of the subsequent crops from reviving, and one might prefer therefore a late-seasonal species as *Hygrophorus firmus* to indicate the seasonal run. Similarly, the crop of epiphyllous agarics may occur out of order: in the Gardens Jungle there may be a small crop in June because the surface of the humus dries in a few windy days and a single heavy storm may penetrate the rather light canopy and soak it. But how often or at what short intervals of dormancy or vegetative growth the toadstools of the first two crops can be made to fruit under such circumstances I cannot state. Nor is it known how mycelia remain dormant in dry soil; few species have sclerotia.

Observations on crops of Boleti, as the most easily recognised indicators of a succession, would in the virgin mountain forest give a valuable clue to the climate. For instance, in the ridge-forest on Gunong Panti in S.E. Johore I have never seen a run of fungus though I have visited it in most months of the year and when there has been a run on the lower slopes: it is a long, narrow and disconnected mountain about 1600′ high and its climate, which must be intermediate between that of the East and West coasts, is generally wet.

Species in Secondary Habitats

The environmental factors controlling the growth of fungi are much more equable in the high forest than in the open or in secondary jungle, and the fruiting of agarics in such places may be irregular. All such places, in fact, as lawns, pastures, orchards, estates and other clearings, must be considered secondary habitats because the land was originally covered with high forest and malayan fungi are primarily forest dwellers. Agarics of secondary habitats fruit also in crops in response to the same stimulus as the forest species but, because of the openness of their habitat, their mycelial growth is checked more readily by short dry spells and promoted again by lighter and

less prolonged rain. Of this kind are several species of Hygrophorus related to *H. puniceus* and *H. conicus*, Lepiota, Marasmius, Clitopilus, Leptonia, Galera, Naucoria, Coprinus and Psaliota on lawns or pastures, and of Pleurotus and Pluteus together with *Schizophyllum commune, Collybia apalosarca, Flammula dilepis, Lentinus sajor-caju, L. subnudus,* and *L. Lecomtei* on logs in the open. They do not fruit continuously in wet weather nor will they fruit without an interval for vegetative growth after each crop. As already mentioned, I have proved this by growing several of the lignicolous kinds under equable conditions: no fruit-bodies grew when the logs were kept continuously damp during 3–6 months but, when they were dried for 10 days and then sprayed, an abundant crop was obtained. Indeed the best way to study lignicolous agarics is by collecting logs from the forest in the wettest weather, drying them gradually in a shady place for 10 days and then spraying them frequently: the variety of basidiomycetes which develop is often incredible.

The only agarics which I have found fruiting continuously under wet conditions are coprophilous ones, which grow and fruit till their habitat is exhausted, and some lignicolus species of Mycena, Collybia, Marasmius and Pleurotus with small fruit-bodies, yet even they respond to the stimulus of drying and wetting.

The Termite-Agaric, Collybia albuminosa (Berk.) Petch.

So irregular is the fruiting of this species that I can form no opinion about it. As Petch noted (A. R. B. Gdn. Perad. 1913, 5,323) it fruits from inhabited nests, but it seems not to fruit more than once from the same nest, at least in Singapore where, however, most nests are rather small, and so one cannot watch the same place repeatedly. It fruits at any time of the year, even in the dryest weather on lawns which are browning, and though there are many nests in the Gardens Jungle from which it could develop it gives no special crop in a seasonal run of toadstools.

The Fruiting of other Basidiomycetes.

It appears that all kinds of Basidiomycetes, fruit in Malaya according to their season exactly as the agarics, but I have few detailed observations on others. The rain which starts a run of agarics starts also the fruiting of the woody Thelephoraceæ, Hydnaceæ and Polyporaceæ, most of which become noticeable rather late in the succession because their fruit-bodies grow slowly, though a few, like Favolus and some Hydnums and Polypores, grow fast and come with the second crop of agarics. The dry weather

checks also the growth of the perennial fruit-bodies of Fomes, Stereum and Hymenochæte and they form a new layer of tubes or hymenium in the wet weather: hence, in a normal year, these fruit-bodies develop two layers of tubes or hymenium, unless they have grown in secondary habitats when they may develop more numerous and narrower layers. Even the resupinate fruit-bodies of Poria, Corticium and Odontia become stratified in this way.

Most Clavarias fruit with the second or third crop of agarics, but the coriaceous fruit-bodies of Lachnocladium generally develop later with the fourth crop. There are Clavarias, however, which fruit late in the season.

Lycoperdon, Calvatia, Scleroderma, Mitremyces and the subterranean forms, as Hymenogaster, Hydnangium, Leucogaster and Dendrogaster, fruit with the second or third crop of agarics: the fruit-bodies of some develop as rapidly as those of Amanita. The Nidulariaceae, Geasters and *Tylostoma exasperatum* fruit later with the fourth or fifth crops, but I have not been able to watch them. In the forest at Tembeling, in Pahang, during the second and third weeks of November 1930, there was a remarkable fruiting of some ten species of Geaster: the fruit-bodies developed mostly on the deep humus between the buttresses of tall trees and at the base of some the humus was almost covered: yet most of these I have not seen elsewhere in Malaya or, indeed, another such crop at any time. The season of the phalloids I do not know. Dictyophora, in the Botanic Gardens, fruits irregularly with the toadstools of the lawns: other kinds I have found too seldom to generalise.

Most Auriculariaceae, Tremellaceae and Caloceraceae fruit early in the succession, with the second and third crops of agarics, but there are some which fruit late.

Comparison with Temperate Countries.

Of the genera of agarics common to tropical Asia and the north temperate region, those are best represented in the tropics whose species fruit chiefly in the late summer or early autumn in the temperate region. Dry weather in May or June in England, followed by rain in June or July, will the cause the fruiting in July or August of many species of the following genera:— Amanita, Amanitopsis, Lepiota, Hygrophorus, Laccaria, Russula, Lactarius, Marasmius, Cantharellus, Clitopilus, Leptonia, Entoloma, Pluteus, Inocybe, Astrosporina, Psaliota, Hypholoma (sect. *H. appendiculatum*), Psathyra. Boletus and Paxillus. And these genera are well represented in Malaya, there being, for instance, several species related to *Amanita caesarea* of southern Europe, and malayan toadstools in general resemble

those of the southern United States. In contrast, Tricholoma, Clitocybe, Collybia, Pholiota, Cortinarius, Hebeloma, Naucoria, Tubaria, Flammula, Stropharia, Hypholoma (sect. *H. fasciculare*), Gomphidius, Psilocybe and Panaeolus, whose species fruit mostly in late autumn and early winter in Europe, are poorly represented. I have not seen a single specimen of Tubaria or Gomphidius in Malaya———(*G. roseus* Mass. non (Fr.) Quel., described from Singapore, is probably *Paxillus lateritius* Petch and, certainy, no Gomphidius)———and only one Phlegmacium, one Hebeloma and one Psilocybe. Gomphidius, however, is typically associated with forests of Abietineæ and these are absent from Malaya.

It seems that the agarics of temperate countries can be divided roughly into two groups:—1. those which are related to tropical species and which fruit, like them, at relatively high temperatures in response to summer drought followed by late summer rain; 2. those which are truly temperate and fruit at relatively low temperatures in late autumn, winter or spring and perhaps only after night-frosts or prolonged cold rain.

Summary.

Each normal year agarics have two general fruiting seasons in south Malaya, perhaps over the whole country. A succession of species then develops for some three months. Each has its own short season of about a week in full fruit and most, especially Amanita, Russula and Boletus, fruit at the beginning of the succession.

The first season beings in March, the second about August or September. Both follow immediately the change from dry to wet weather. The stimulus to fruit is primarily the dry weather which checks mycelial growth, and ensuing rain causes the development of fruit-bodies. Seasonal species do not fruit in prolonged wet weather.

Observations on crops of Boleti in the forest would give valuable evidence of the local climate.

Agarics in open places fruit more often because their habitat is more exposed to alternate drying and wetting.

Most other basidiomycetes fruit in the same seasons. Perennial fruit-bodies normally develop two new layers each year.

Malayan agarics in their kind and manner of fruiting resemble the summer and early autumn agarics of temperate lands.

A FEW ORCHIDS FROM THE MALAYAN ARCHIPELAGO.

By J. J. Smith,

Oegstgeest, Holland.

Oberonia (sect. Hymenobractea, incl. Platystreptus) **Latifii** J. J. S. np.

Caules approximati, elongati, compressi, serpentini, cum alis vaginarum recti, 12-21 cm. longi, cum vaginis c. 1.2 cm. lati, 10-21-folii. Folia inarticulata, erecto-patentia, plerumque plus minusve falcatula, basin versus decrescentia, summa etiam minora, breviter acuta vel brevissime acute acuminata, parte patente elongato-triangula, basi haud vel vix fissa, 2.1-3.3 cm. longa, 0.6-0.8 cm. lata, cum vagina 4.2-4.6 cm. longa, vaginis sensim in folia vergentia, 0.75-0.8 cm. latis antice fissis, basi tantum tubulosis. Inflorescentia elongata laxe multiflora, c. 20-22 cm. longa, angulata, papillosa. Bracteæ oblongæ, versus apicem angustatæ, irregulariter eroso-fimbriato denticulatæ, concavæ, c. 0.225 cm. longæ, fere 0.1 cm. latæ. Flores in pseudoverticillis 5-6-meris, in inflorescentiæ apice basique irregulariter dispositi, patentissimi vel subpatentissimi, parvi, c. 0.2 cm. diam., sepalis petalisque patentissimis, apice leviter recurvulis. Sepalum dorsale ovatum, obtusum, convexum, basi concavum, bene 0.1 cm. longum, 0.06 cm. latum. Sepala lateralia ovata, acutiuscula, convexa, bene 0.1 cm. longa, 0.07 cm. lata. Petala divaricata, leviter recurvula, oblonga, obtusa, basi paululum angustata, convexa, margine papillosa, fere 0.1 cm. longa, 0.04 cm. lata. Labellum basi auriculis oblique rotundatis gynostemium semiamplectens, concavitate antice rotundata ad basin, 3-nervium, antice in lobum medium cum auriculis angulos rotundato-obtusos facientem ambitu quadrangulum apice leviter angustatum angulato-retusumque margine papillosum contractum, expansum 0.1 cm longum, ad auriculas fere 0.1 cm. latum, lobo intermedio 0.06-0.07 cm. longo, 0.05 cm. lato. Gynostemium breve, rectum, a dorso compressum, dorso convexum, cum anthera 0.04 cm. longum. Anthera cucullata, transverse ovalis. Pollinia 4, in corpuscula 2 ovalia plus minusve obovata unita. Stigma transversum, semilunatum. Ovarium densius patentissime papillosum, 0.06 cm. longum; pedicellus minus dense papillosum, 0.16 cm. longum.

Sumatra:—West Coast, environs of Kajoe Tanam, 150 m. (S. M. Latif n. 13, November, 1934).

This belongs to the group of species on which Schlechter based his sections *Hymenobractea* and *Platystreptus*. In habit it approaches *Hymenobractea*, in the shape of the flowers *Platystreptus*, but it is questionable whether these groups, even when united, may be retained as a section.

O. Latifii is a near ally of *O. monstruosa* Lndl. but the leaves are much more numerous and denser and the lip much less contracted.

Description from herbarium specimen, for which I am indebted to Mr. Latif.

Dendrobium (sect. Calcarifera) **Paathii** J. J. S. in "De Orchidee" IV (1935) 183.

Caules elongati, deinde ramosi. Inflorescentiæ e nodis caulium defoliatorum, ut videtur semper unifloræ, pedunculo tenui c. 1.3 cm. longo. Bractea adpressa, triangula, c. 0.26 cm. longa. Flores conspicui c. 4.4 cm. longi, 2.75 cm. lati. Sepalum dorsale erectum, recurvulum, convexum, oblongo-ovatum, apice angustatum, obtusum, 1-nervium cum nervis minoribus intermixtis, c. 1.85 cm. longum, 1 cm. latum. Sepala lateralia lacinia conspicua oblique lineari-oblonga concava ad pedem gynostemii decurrentia, marginibus anticis versus pedis apicem contigua longitudine c. 0.45 cm. connata, mentum magnum calcariforme cum ovario angulum acutum vel subrectum faciente fere rectum ultra medium leviter recurvulum apice abrupte incurvum truncato-obtusum antice canaliculatum apice antice bilobulum 2.4 cm. longum apice 0.525 cm.latum formantia, parte libera recurva, oblique ovato-triangula, obtusa, marginibus leviter curvatis, c. 8-nervia, c. 1.95 cm. longa, margine antico 3.65 cm., basi 2.5 cm. metientia. Petala apice recurva, laxe undulata, oblique rhombea, obtusa 3-nervia, nervis exterioribus bene ramosis, bene 2 cm. longa, 1.15 cm., basi 0.33 cm. lata. Labellum basi longitudine c. 0.6 cm. pedi gynostemii adnatum, deinde arcuato-recurvum et incurvum, subparallelum pedi gynostemii erectum unguiculatum, cuneato-spathulatum, 3-lobum, lobis lateralibus erectis concavum, leviter undulatum, gynostemium superans, subtus tota longitudine sulcatum, ungue ad basin partis liberæ incrassatione transversa carnosa margines unguis connectente postice in crura 2 basin versus producto antice fimbriato instructo, costa brevi longitudinali (glandula) inter crura, intus ante incrassationem ad basin laminæ verruculosum, 3-costatum, costis approximatis angustis convexis simplicibus, costa media basin lobi intermedii usque producta, lateralibus humilioribus brevioribusque inexplanatum 3.85 cm. longum, explanatum fere 4 cm. longum, ad lobos laterales 2 cm. latum, ungue toto c. 1.2 cm. parte connata 0.8 cm. longo; lobi laterales expansi sinibus subrectangulis plicaque introrsa a lobo intermedio separati, oblique trianguli, obtusi, margine antico leviter rotundati, costula inconspicua intus marginem lateralem mesochylium cuneatum antice truncatum infra apicem satis distincte contractum 2.1 cm. longum apice 2 cm. infra apicem 1.6 cm. latum formantes lobus intermedius erectus, leviter sigmoideus angulato-convexus, anguste triangulo-oblongus, obtusus, basi margine minute transverse rugulosus, carnosulus c. 1.1 cm. longus, basi 0.6 cm., medio 0.73 cm. latus. Gynostemium breve, oblique conicum, dorso convexum, absque anthera 0.5 cm. longum, clinandrio excavato, transverse quadrangulo, filamento satis longo, vix curvulo lineari, auriculis porrectis, verticalibus, filamento æquilongis, ovato-triangulis, breviter acuminatis, acutis vel obtusis. Anthera

cucullata, oblique cubica, dorso transverse gibbosa, postice canaliculata, apice producta truncata papilloso-hirtella, c. 0.4 cm. longa, 0.3 cm. lata. Pollinia 4, lateraliter compressa anguste obovato-pyriformia, 0.3 cm. longa. Rostellum appendice semor biculari margine incrassato (viscido?) basin stigmatis obtegente instructum. Stigma conspicuum, basin gynostemii fere attingens oblongo-quinquangulare circiter dimidio inferiore contractum. Pes gynostemii cum ovario angulum acutum vel subrectum faciens elongatus leviter sigmoideus, apice bene incurvus et ungui labelli adnatus, linearis canaliculatus apice incurvo magis excavatus et glandula costiformi longitudinali donatus 2.45 cm. longus. Ovarium teres 6-sulcatum, 0.9 cm. longum, cum pedicello tereti leviter sigmoideum.

Borneo:—Westerafdeeling, Goenoeng Raja near Singkawang. (J. J. Paath, April, 1935; "sepals and petals white, lip yellow, streaked orange in the throat, midlobe white").

A very distinct member of the section *Calcarifera* of which I do not know a very near ally.

Description from 2 flowers preserved in alcohol.

Dendrobium (sect. Distichophyllum) **singkawangense** J. J. S. n. sp.

Caules approximati, c. 20 cm. longi, flexuosi internodus c. 1.7 cm. longis. Folia patentissima, apice recurvula, oblonga, apice oblique rotundato-bilobula, ut videtur initio nigro-pilosa, costa media supra sulcata subtus prominente, c. 4.3 cm. longa, 2.3-3.3 cm. lata; vaginis internodia æquantibus.

Inflorescentiæ vaginam dorso ad basin perforantes, brevissimæ, 3-4-floræ, rachide nonnullis pilis adpressis partim ramosis nigris inspersa c. 1-2 cm. longa. Bracteæ oblongæ acutiusculæ, concavæ, dorso et etiam intus ad apicem marginemque pilis 1-3-ramulosis grossiusculis nigris vestitæ, c. 8-nerviæ nervis 3 mediansi usque ad apicem productis membranaceæ 1.175 cm. longæ, 0.475 cm. latæ. Flores carnosuli, c. 2.9 cm. lati, 2.8 cm. longi. Sepalum dorsale cum ovario angulum obtusum faciens, levissime sigmoideum porrectum, secundum costam mediam canaliculatum subovatum, apice triangulo-contracto-acuminatum, satis acutum, margine superne subirregulare basi latum 7-nervium, c. 1.6 cm. longum, fere 0.8 cm. latum. Sepala lateralia cum pede gynostemii mentum conicum rectum cum ovario angulum acutum faciens dorso longitudinaliter bicanaliculatum basi utrinque gibbiforme parte superiore calcariformi-contractum cum marginibus anticis fere omnino liberis contiguisque obtusum 1 cm. longum formantia divergentia angulum acutum facientia, secundum costam leviter canaliculata obtusangule triangula, acuta breviter apiculata, apice subirregulariter marginata, dorso obtuse carinata, 7-nervia c. 1.75 cm. longa, margine antico 2.5 cm. basi 1.35 cm. metientia. Petala divergentia, apice recurvula oblique ovata, 2/5 partibus superioribus triangulo-contracto-acuminata acuta, basi utrinque rotundata medio tantum

affixa, 3-nervia, nervis exterioribus ramosis, textura sepalis tenuiora, 1.75 cm. longa, 1.05 cm. lata. Labellum ungue parti superiori pedis gynostemii calcariformi-connatum, 3-lobum, concavum, lobis lateralibus gynostemium æquans, subtus inter lobos laterales leviter longitudinaliter canaliculata, intus inter lobos laterales incrassatione longitudinali leviter 3-costulata in lobo intermedio in costas 3 valde verruculosas apicem labellifere attingentes exeunte, 5-nervium, nervis lateralibus valde ramosis nervis ramisque omnibus in lobo intermedio valde verruculosis ceterum serie unica verrucularum instructis, inter nervos in lobo intermedio humilius verruculosum, in basi laminæ fascia longitudinali glabra excepta papillosum, expansum totum ambitu, rhombeum, fere 2.5 cm. longum, 1.5 cm. latum, ungue oblongo, longitudine 0.6 cm. pedi gynostemii adnatum; lobi laterales erecti, rotundato-trapezoidei, antice vix producti margine antico leviter irregulares, mesochylium æquilateraliter trapeziiforme c. 1.1 cm. longum formantes; lobus intermedius cum lateralibus angulos acutos faciens, porrectus, recurvus, undulatus, irregulariter marginatus, expansus quinquangularis, apice angustatus, obtusiusculus, 0.9 cm. longues, 0.75 cm., basi 0.575 cm. latus. Gynostemium rectum subconicum dorso convexum, subtus planum, cum anthera 0.525 cm. longum, filamento longo, filiformi-subulato, auriculas paululum superante, auriculis triangulis, acutiusculis margine postico leviter serrulatis concavis. Anthera cucullata antice visa quinquangularis, dorso obtusa retusaque, apice in appendicem transversam subtruncatam vix retusam dense hirtellam producta, omnino minute cellulosa, 0.25 cm. lata. Pollinia 4 in corpuscula 2 unita lateraliter compressa, oblique oblonga vix curvula, 0.175 cm. longa. Stigma basin gynostemii attingens, oblongo-ovale, vix urceolatum, basi rotundatum apice truncatum. Pes gynostemii cum ovario angulum acutum faciens, rectus, canaliculatus, fere dimidio superiore labelli ungui adnatus et angustior, parte lata dorso conspicue bicanaliculatus, 1 cm. longus. Ovarium oblique obconicum, 6-sulcatum, cum pedicello angulum obtusum faciens, 0.65 cm. longum; pedicellus teres c. 2.5 cm. longus.

Borneo:—Wester Afdeeling, Singawang, alang-field with scattered trees, epiphytical (F. J. Paath, 20 October, 1934; "flowers creamy white, midlobe of the lip inside bright orange").

A distinct species of the group *Nigrohirsuto* of the section *Distichophyllum*. The lip is very warty inside, as in *D. ovipostoriferum* J. J. S., *D. Hallieri* J. J. S. etc., but it is very different from any of the species known to me in the rather short mentum, in the side lobes, which are very large as compared with the midlobe, and in other characters. In the shape of the ovate acute petals it somewhat resembles *D. Hallieri*.

By the good offices of the editor of "De Orchidee" I received flowers preserved in spirit and photographs from which the description has been made.

THE EPIPHYTIC FLORA OF DIPTEROCARPUS OBLONGIFOLIUS, Bl. ("Neram").

By M. R. Henderson,

Botanic Gardens, Singapore.

Dipterocarpus oblongifolius, Bl. is a common tree on the banks of rivers and streams, especially east of the Main Range of the Malay Peninsula, and is abundant on some of the tributaries of the Pahang river. It appears to be confined to riverbanks, and is a massive tree, though not usually tall as compared with other Dipterocarps.

Its ability to grow on steep banks and its resistance to floods are remarkable. This is probably due in part to its root system. Judging from specimens seen which had their roots exposed by floods, the roots do not penetrate deeply into the soil but spread over a large area and are so tenacious that the whole top of a tree may be wrenched off by pressure of floodwater and driftwood, leaving the roots and lower part of the trunk undisturbed.

Where the trees grow on steep banks, the base of the trunk is almost at right angles to the bank. The more nearly perpendicular the bank the more nearly horizontal the base of the trunk, which then curves gradually upwards but seldom attains a perpendicular position. The same method of growth may be observed in such plants as *Pandanus* growing on very steep limestone cliffs. The upper surface of the basal portion of the trunk of the *neram* is extended into a flange, so that a cross section of the trunk at this point would be roughly a triangle with a rounded base, or somewhat pearshaped. This extension of the trunk no doubt acts as a stay, and the tree is actually not buttressed in any way, as there is no buttress development on the lower surface of the trunk, and less development of roots in the direction of the water than in other directions.

In some localities the *neram* trees carry a large and varied epiphytic flora, which is more easily examined than that on tall forest trees, as the former are usually not difficult to climb and can be examined from the streambed with comparative ease. A census of this epiphytic flora was attempted during an expedition to one of the small tributaries of the Tembeling river (Sungai Sat) in July, 1929 and to Sungai Ketil, Kelantan in the following month. It is noticeable that on the banks of the larger rivers, such as the Tembeling in Pahang and the Lebir in Kelantan, where the original vegetation has been cleared, the *neram* trees, where they have been allowed to remain, carry few epiphytes, but on the smaller rivers, where the original vegetation has not been destroyed, and where the trees meet overhead, epiphytes are much more numerous. The luxuriance of the epiphytic flora,

however, varies in a curious way. For instance, the trees along the Sungai Terang, a small tributary of the Lebir, carried few epiphytes compared with those on the Sungai Sat, although one would have said that the conditions were more favourable on the former river. The same applies to the epiphytic flora of *Saraca*. In some places these trees are loaded with small orchids, while in other apparently similar localities they bear none.

It was found that the orchids were the most numerous and for this reason they were given more attention than other groups. For the identification of these I am indebted to Mr. C. E. Carr, whose detailed knowledge of the local orchid flora enabled him to identify most of the specimens although they were not flowering.

The method adopted was to send one or two men up the tree with instructions to strip off and throw down every epiphyte they could see. Branches were cut off and examined for such small plants as *Taeniophyllum*, and field glasses were used to ensure that nothing was missed. As far as possible identifications were made on the spot, and anything which could not be dealt with in this manner was preserved for future study. Probably about 10—20 per cent. of the total area of each tree was examined, the search being naturally restricted to the trunk and lower, stouter branches. Without felling the tree the canopy could not be examined. Many *Taeniophylla* are often confined to one or two branches and do not spread over the whole tree, and some species such as *Thrixspermum* grow amongst the leaves towards the tips of the branches in more or less full sunlight. However, the proportion of the epiphytic flora enumerated here is considerably more than 20 per cent. of the total, as the bulk of the epiphytes grow on the trunk and lower branches.

It was found impossible to make a count of individual plants. Some orchids and such ferns as *Drynaria quercifolia* were exceedingly abundant on some trees.

The following are the flowering plants (excluding orchids) and ferns :—

Vitis macrostachya, Miq.; Vitis sp.; Pachycentria tuberculata, Korth.; Medinilla Hasseltii, Bl.; Medinilla sp.; Schefflera Ridleyi, Vig.; Myrmecodia tuberosa, Jack; Hydnophytum formicarium, Jack; Vaccinium acuminatissimum, Miq.; Rhododendron Teysmanni, Miq.; Hoya latifolia, Don; Hoya sp.; Fagraea auriculata, Jack; Aeschynanthus radicans, Jack; Helixanthera coccinea, Dans.; Ficus consociata, Bl.; Ficus diversifolia, Bl. var. Kunstleri; Ficus diversifolia, Bl. var. ovoidea; Ficus parietalis, Bl.; Pothos sp.; ?Anadendrum sp.; Asplenium pellucidum, Lam.; Asplenium spathulinum, J. Sm.; Cyclophorus varius, Gaud.; Drynaria quercifolia, L.; Humata angustata, J. Sm.; Humata heterophylla, Desv.; Platycerium Ridleyi, Christ.; Polypodium lomarioides, Kze;

Polypodium mettenianum, Ces.; Polypodium phymatodes, L.; Polypodium revolutum, C. Chr.; Polypodium sinuosum, Wall.; Trichomanes minutum, Bl.; Trichomanes pallidum, Bl.; Vittaria elongata, Sw.; Vittaria ?ensiformis, Sw.; Lycopodium laxum, Spr.; Lycopodium nummularifolium, Lycopodium phlegmaria, L.; Lycopodium phyllanthum, H. & A.

Six trees were examined particularly for orchids and the results are given in tabulated form below. The first three trees were in a group together, numbers four and five were together some distance upstream, and number six was on another small stream about a mile distant from the others.

——	1	2	3	4	5	6
Oberonia anceps, Lindl.			x			
Hippeophyllum Scortechinii, Schltr. ...			x			
Platyclinis longifolia, Hemsl. ...			x		x	
Dendrobium acerosum, Lindl. ...	x				x	
,, atropurpureum, Miq. ...			x			
,, bifarium, Lindl. ...		x				
,, eulophotum Lindl. ...	x				x	
,, Farmeri, Paxt. Mag. ...		x	x	x		
,, fugax, Schltr. ...		x	x			x
,, grande, Hook. f. ...					x	
,, Hosei, Ridl.				x	x	
,, indragiriense, Schltr. ...					x	
,, leonis, Rchb.				x		x
,, lonchophyllum, Hook. f.					x	
,, pensile, Ridl.	x	x	x	x	x	
,, pumilum, Roxb. ...	x			x	x	x
,, serra, Lindl.			x		x	
,, teres, Lindl.	x					
Bulbophyllum odoratum, Lindl. ...					x	x
,, lepidum, J.J.S. ...	x	x		x		x
,, medusae, Rchb. f. ...					x	x
,, purpurascens, Teysm. ...				x	x	x
,, restrepia, Ridl. ...	x					
,, vaginatum, Rchb. f. ...	x	x				x
Eria floribunda, Lindl.	x	x		x	x	
,, neglecta, Ridl.				x		x
,, suaveolens, Ridl.	x	x		x	x	
,, xanthocheila, Ridl.		x				x
Trichotosia Teysmanni, Kranzl. ...		x				x
,, velutina, Kranzl. ...	x					
Tylostylis rigida, Bl.			x			
Coelogyne Rochusseni, De Vr. ...	x		x	x		
,, testacea, Lindl. ...			x			
Cymbidium pubescens, Lindl. ...	x	x				x
Grammatophyllum speciosum, Bl. ...				x		
Saccolabium Hendersonii, Carr ...					x	
,, undulatum, Ridl. ...			x			

——	1	2	3	4	5	6
Renanthera elongata, Lindl. ...	x					
Sarcanthus Scortechinii, Hook. f. ...		x				x
Pomatocalpa Kunstleri, J.J.S. ...		x				
Sarcochilus pusillus, Rchb. f. ...			x			
,, virescens, Ridl. ...			x			
Taeniophyllum obtusum, Bl. ...			x			x
Poaephyllum pauciflorum, Ridl. ...		x	x			x
Appendicula cornuta, Bl.		x				x
Podochilus tenuis, Lindl.						x
Agrostophyllum bicuspidatum, J.J.S. ...	x	x	x	x	x	x
,, Hasseltii, J.J.S. ...	x	x	x	x	x	x
Oxyanthera decurva, Hook. f. ...						x
Thrixspermum pardalis, Carr ...			x			
Number of species on each tree ...	16	17	19	14	18	20

There were also two Eria spp. of the section *Hymeneria,* and a Bulbophyllum of the section *Aphanobulbon,* unidentified. Fifty known species and three unidentified species were therefore found on these six trees. The two species occurring on all six trees were *Agrostophyllum bicuspidatum* and *A. Hasseltii.* The only species common to the three trees close together were *Agrostophyllum bicuspidatum, A. Hasseltii* and *Dendrobium pensile.*

The following orchids were found on other *neram* trees :—

Liparis lacerata, Ridl.
Dendrochilum sp.
Dendrobium aggregatum, Roxb.
,, crumenatum, Sw.
,, Haniffii, Ridl.
,, luxurians, Carr
,, salaccense, Lindl.
,, flavidulum, Hook. f.
Bulbophyllum abbrevilabium, Carr
,, clandestinum, Lindl.
,, tortuosum, Lindl.
Eria pendula, Ridl.
,, pannea, Lindl.
,, leiophylla, Lindl.
,, stellata, Lindl.
,, biflora, Griff.
Trichotosia vestita, Kranzl.
Chelistonele sp.

Coelogyne Kingii, Hook. f.
,, stenophylla, Ridl.
Cymbidium aloifolium, Sw.
Acriopsis javanica, Reinw.
,, sp.
Agrostophyllum majus, Hook. f.
Bromheadia alticola, Ridl.
,, rupestris, Ridl.
Dilochia Wallichii, Lindl.
Thrixspermum arachnites, Rchb. f.
,, rubrocallosum, Carr
Taeniophyllum pahangense, Carr
Sarcochilus biserratus, Ridl.
Ceratostylis pendula, Hook. f.
Sarcanthus halophilus, Ridl.

The total number of species of orchids found on *neram* within a limited area is thus eighty-seven.

As a contrast to the *neram* flora, two trees of *Saraca bijuga* were examined for orchids and their flora was found to consist mainly of the following :—

Dendrobium subflavidum, Ridl.
Bulbophyllum nigropurpureum, Carr
Chamaeanthus laciniatus, Carr
Saccolabium Hendersonii, Carr
,, undulatum, Ridl.
Sarcochilus caligaris, Ridl.
,, ciliatus, J.J.S.
,, incurvicalcar, J.J.S.
,, pusillus, Rchb. f.
,, siamensis, Carr
Pomatocalpa Kunstleri, J.J.S.
Thrixspermum arachnites, Rchb. f.
Taeniophyllum obtusum, Bl.
,, rugulosum, Carr
Appendicula pendula, Bl.

It will be noticed that none of the commonest orchids on *neram* occur on *Saraca, e.g.* Dendrobium pensile, D. pumilum, Bulbophyllum lepidum, Eria floribunda, E. suaveolens, Agrostophyllum Hasseltii, A. bicuspidatum, are absent. The orchid flora of *Saraca* consists mainly of small plants such as Saccolabium, Sarcochilus, Thrixspermum, Taeniophyllum, etc., and large plants, such as Grammatophyllum, Coelogyne, Cymbidium, etc. are conspicuous by their absence.

PHYLOGENY OF SINGLE FEATURES,

as illustrated by a remarkable new Sapotaceous tree from British Malaya (Madhuca Ridleyi, n. sp.).

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In older works concerning the field of phylogenetic taxonomy, families and genera were considered as more or less static entities. It was accepted that they wandered both through time and through space, and also that, as they developed, or in general changed by evolutional processes during that journey they helped to form that much-discussed, but ever-mysterious structure, the genealogical tree. Such expressions as: the genus A has probably given rise to the genus B, the genus C is to be derived from the genus D, the genera E and F have common ancestors with the genus G, etc., are characteristic of those days. Although dynamic in the sense of evolution, these taxonomic units were, in fact, static entities, as they were considered to travel and to change as units.

However, taxonomic ideas are not the same nowadays. Genetics arose and developed and, being in some way the branch of science, which covers the phylogeny of living species, greatly influenced the ideas of taxonomical and phytogenetical investigators. Instead of a static treelike structure as the old extreme, we got, as the extreme opposite concept, a sort of dynamic network, comparable with the creeping plasmodium of a slime-mould. No fixed units any more, only a series of ever-changing combinations of a constant number of genetical factors (HAYATA). Although few will agree with an extreme dynamic system like his, the remarkable ideas of this author are certainly both characteristic of, and, to some degree, also responsible for the change of our thoughts. At any rate, the former families, genera, etc., are considerably less solid, not only in a taxonomic, but especially in a phytogenetic sense. Feeling that the old tree is as unsatisfactory as the slime-mould plasmodium to serve as a symbol for our ideas concerning phylogenetical processes, we are nowadays trying to find some "golden mean". We do that, for instance, according to an old and approved recipe, by analysis of the material available; in other words, we are no longer examining the tree and the slime-mould as a whole, but we try to look for what parts they are made of: we study single features. The features, whether determined by a single genetical factor or by a group of such factors, certainly have more right to be called the true taxonomical-genetical units than the individuals. During my investigations on Malaysian Burseraceæ (**5, 6**) I became more and more convinced of the value of this phylogeny of features

("Merkmalsphylogenie"; ZIMMERMANN); next to this my attention was drawn to the idea that features could, alone or in combination with others (coupling of factors), travel, fairly independently, not only through time but also through space for long periods (Paleogeography of features as *e.g.* practised by LYMAN B. SMITH, **7**). It seems possible that a middle course between the tree and the slime-mould may be found by accepting that all combinations of factors (features) and all grades of strength or duration of a coupling may occur. Evolution would mean in that case : a certain, yet undiscovered, trend in the way in which features cling together or in which certain combinations succeed each other. Both hybridization (LOTSY) and mutations (HUGO DE VRIES) find their place in this concept.

As in all phylogenetic studies, paleobotanic data are of principal importance, but as these are too often wanting we have to look for what taxonomy (morphology) and geography (distribution) may teach (VON WETTSTEIN). A careful and critical study of these data may give us an idea of the possible phylogeny of what we call a taxonomic unit. We shall then see, I expect, that generalisation is not possible in the way we were used to; that every genus, etc., has to be investigated quite separately, and that conclusions of a general nature may only be relative to the fundamental laws of evolution. These considerations leave the way open to a process of the origin of genera and families, which I think has been taken into account only too little up to now, *viz.* through polyphyletic evolution.[1] On account of our present knowledge I prefer a phylogenetic symbol in the form of a network-structure, extremely minute and dynamic at every point representing the present, and extremely coarse and static, as viewed from these points, in the farthest past; we have to bear in mind, however, that this structure is no reality but just a human attempt to grasp a complicated problem.

At the time that I studied Malaysian Sapotaceæ (**1, 2, 3, 4**), these ideas had not yet evolved in my mind. However, having taken up these studies[2] again with the aid of some collaborators, I have come upon some facts which perfectly fit into the above considerations, and I am glad to mention here an example of the probable phylogeny of a single feature, illustrated by a new species of *Madhuca,* which I am very much pleased to dedicate to the nestor of Malayan and Malaysian[3] botanists, Mr. H. N. RIDLEY, on the occasion of his 80th birthday. I have named it *Madhuca Ridleyi*; a diagnosis and a picture of the species may be found at the end of the present paper.

1 I hope to report on a striking example concerning this before long.

2 Publication of a revision may be expected next year.

3 Malaya = Malacca = the Malay Peninsula (British Malaya), which in this paper is considered as forming phytogeographically a part of Malaysia : Malaysia = the Malay Archipelago ; the word has, if I am not mistaken, been introduced by E. D. MERRILL.

As appears from may earlier papers (**1,** p. 11, 110–112), *Madhuca* is one of four genera (the others are *Payena, Ganua* and *Burckella,*), together forming the group of the *Palaquiinæ-Madhuceæ-Eumadhuceæ*, well characterized by the possession of two whorls of two sepals each.

Let me begin with some words as to what may be suggested regarding the phylogeny of these four genera. As we know nothing about fossil *Madhuceæ*, we have to look for what data recent representatives have to yield. First of all we have to state, that all of the four genera are very closely related, which is illustrated by the great trouble it took to find a means of subdivision, as all features are very irregularly distributed over the genera. Apparently the *Eumadhuceæ* form a group which is in a state of initial differentiation into four branches; a differentiation, nevertheless, distinct enough to claim different names for the branches.

Valuable data may now be expected in the present distribution of species and features.

Distribution of species. As appears from the accompanying table (Pl. 3) and the map (Pl. 4), the group is restricted to S. Eastern Asia (Western limit: Deccan Peninsula and Ceylon) and Polynesia (as far east as Fiji, Samoa and Tonga) with a very distinct centre of differentiation in Western Malaysia (British Malaya inclusive).

According to orthodox ideas of historical phytogeography, our table (Pl. 3) confirms some well-known facts, obvious also in many other plant families, *e.g.*

1. that the phytogeographic relations between British Malaya and the greater Sunda Islands (especially Sumatra and Borneo) are extraordinarily strong (cf. **2,** p. 384–385, table; and **3**);
2. that next to a line of dispersion from Malaya to Sumatra, a very important line is that from Malaya to Borneo and the Philippines (Palawan !);
3. the hypothesis that this region which in a former period is supposed to have formed one big land mass that split up in postglacial times, has been an important source and centre of dispersion of plant groups, the areas of which are now disjunct.

On account of these considerations I would suggest that the *Eumadhuceæ* have originated in that former land mass, the so-called Sunda-land. From this centre, the group has spread geographically, during its morphological differentiation, both in western direction (continent of Asia) and towards the East, and the isolation of the various islands then gave rise to endemic species (the Philippines—*Madhuca*—and also New Guinea—*Burckella*—have apparently acted as secondary regions of differentiation), while other species remained unchanged everywhere or perhaps evolved in the same way in different places.

Of the three genera *Madhuca, Payena* and *Ganua* (cf. Pl. 3, 4 and 5), *Madhuca* covers the largest area and contains the greatest number of species. The differentiation of these genera mutually is both geologically and morphologically very young; *Ganua* has apparently its centre in Borneo (3 endemic species) with offshoots to British Malaya, Sumatra and Palawan (non-endemics) and, curiously enough, one isolated species in the Moluccas;[1] *Payena*, with greater area than *Ganua*, and also with stronger differentiation, is geographically intermediate between *Madhuca* and *Ganua*. Morphologically *Ganua* is developing in the direction of a peculiar venation of the leaves, of imperfect septa in the ovary and of dry fruits. *Payena* is distinguished by a well-characterized venation and a tendency to form a voluminous endosperm and *Madhuca*, with which *Payena* is connected by many transitional species, shows, besides a type of venation of its own, a tendency to reduce the endosperm. *Burckella* is the only genus that is more distinct morphologically, but especially geographically. In contradistinction to the other genera it does not follow the age-and-area theory, as the number of its species is small and its area large. Yet I see no reason to accept a reduction of the area and to consider the species as relic-endemics, but a biphyletic origin seems to be possible. In its venation it reminds one of eastern *Ganua*-species as well as of a certain type of mostly western *Madhuca*-species (Sect. *Dasyaulus*). It must certainly be remarked that its venation much resembles the type of the two geographically nearest species: *Ganua Bœrlageana* and *Madhuca Burckiana*. It shows, furthermore, a tendency to form very big fruits.

These general indications led me to the assumption that *Madhuca* is the basal group in which the other genera are rooting. Further evidence for this supposition may be found in some features, intentionally left unmentioned thus far.

Distribution of features. The characteristics purposely not yet mentioned are the number of parts in the corolla, the androœceum and the gynæceum. According to what is generally accepted, high numbers may also in this group be considered as representing the more primitive state. In the *Eumadhuceæ* there are two tendencies to be noticed: one to fix the said numbers at P. 8, A. 16, G. 8, and the second (which is, by the way, an extremely general one) to reduce the G. number beyond 8. Now we see that *Madhuca* is the only genus in which all whorls show a great variation *viz.* P. 18–6 (–5?), A. 40–12, G. 21–6. In the other genera P. and A. are, to a much higher degree, fixed to 8 and 16 respectively; G., however, shows a further reduction as far down as 3. It is certainly a striking fact that the highest numbers in the last-named whorl occur in or near the geographical

1 This may be a case of convergence (polyphyletic origin of the genus).

centre of the group and that the lowest ones occur in the most remote parts of the area (*Burckella* in Polynesia and *Madhuca*, although not exclusively, in India and Ceylon).

Our new species, *Madhuca Ridleyi* is, in this respect, to be considered as a representative of a most primitive state, the numbers of parts in its P. and G. whorls being by far the highest known in the whole group, *viz.* P. 18, A. 37 – 36, G. 21 – 18 !

The following facts may elucidate this somewhat more in detail :—

Madhuca. P. 18–6 (–5?) A. 40–12 G. 21–6.

Between these extremes there is a very rich variation. Most species show a variability in all whorls, and often a considerable one, also those which cannot be said to be polymorphous in other respects. Some examples are :

	P.	A.	G.
M. lancifolia ...	14–10	28–22	14–10
Kingiana ...	16–12	36–32	10–8
betis ...	10–8	20–16	8
sericea ...	9–8	24–18	10–8
Endertii ...	7–6	13–12	7–6
macrophylla ...	13–10	28–20	18–11

etc.

M. Ridleyi has the highest numbers for G. As to P. it is only equalled by *M. macrophylla*, as to A. it is only surpassed by *M. Lecomteana* (nom. nov. for *Bassia Thoreliana* Pierre), in which P. = 40–35. Only 3 other species, all from the Malay Peninsula show similar P. numbers, except a Burckella species, discussed below.

Payena. P. 8–6 A. 20–12 G. 8–6.

These extremes are exceptions. About 12 species out of 16 of which all whorls are completely known, show the 8–16–8 arrangement, many others show little variations and only a few, some of which are polymorphous throughout, are more various, *viz. P. lucida* (8–6, 16–13, 8–6), *P. dasyphylla* (8, 20–16, 8), *P. Griffithii* (8-6, 16–12, 8) and *P. truncata* n. sp. (8–7, 16–4, 8?).

Ganua. P. 8–6 A. 24–16 G. (12?–) 9–6.

In this small genus the variability is somewhat more pronounced than in *Payena*. Yet, most of the species are fixed to the 8–16–8 type or almost, and, as in *Payena*, the most striking variability occurs in species that are also polymorphous in other respects, such as *G. Motleyana* (10–8, 20–16, 8–6) and *G. monticola* (8, 24–16, 12?–9–8).

Burckella. P. 8–6 A. (40?–) 18–9 G. 6–3.

There is hardly any variability in the corolla; only one species is said to possess 6 petals. In the androœceum three species have 18–16 stamens, one has 16–9 and one (*B. Thurstonii* [HEMSL.] H. J. LAM, from Fiji) is said to have as many as 40 (p. 8, G. 4).

This fact gives me an opportunity to say a few words on the phylogenetic value of the three whorls mentioned. As may appear also from the following statement, the corolla and the androœceum seem, in general, not to yield valuable and trustworthy data for phylogenetic conclusions. There is only a slight indication as to a reduction of the P and A. numbers in three Ceylon species of *Madhuca* (6–12–6). For the rest, it may even be that these whorls are not always subject to a reduction but may, on the contrary, in some cases, attain higher numbers by progression. This not uncommon phenomenon is *e.g.* illustrated by the figure of the androœceum of *Burckella* (*Bassia*) *Thurstonii* in HOOKER'S Icones Plantarum t. 2569 (XXVI, 1899), in which a petaloid stamen is figured and also by the fact that stamens with halfway split anthers are not rare in the group of the *Palaquiinæ*. This made me refrain from laying any particular stress upon the phylogenetic value of the characters of these two whorls.

The gynæceum, however, being an organ of much less phylogenetic plasticity as a rule, is more reliable in this respect, and shows a distinct reduction in the more remote parts of the area. It does so in all of the four genera; in *Payena* this reduction is hardly conspicuous (down to 6 in 3 out of the 19 species in which this feature is known); in *Ganua*, being also in other features more isolated (ovary, fruit, venation) it become more apparent (down to 6 in 3, to 7 in another of 9 species); in *Madhuca* the genus with the highest G. numbers this reduction is occasionally found (*viz.* down to 6 in 2, 7 in 1 W. Malaysian, down to 5 in 1, to 6 in 7 and to 7 in 1 Continental species). It is also a striking fact that in *M. mindanæensis* the Philippine specimens possess 8, the North Borneo ones (living in a place which is probably colonized from the main area in the Philippines) 6 cells in their ovaries. None of these genera, however, have a G. number below 6. This is only reached in *Burckella* where there are 6, 5, 4 or 3 cells, however, wihout more detailed geographic correlation with the accepted general migration from West to East.

The following table gives the average numbers in the whorls in question in order to show any geographic importance :

—	P.	A.	G.	% of species in which G=							
				>9	9	8	7	6	5	4	3
MADHUCA											
W. Malaysia	9·1 (33 sp.)	20·6 (33 sp.)	9·3 (32 sp.)	**46**	**52**	**66**	13	6	..	..	..
C. & E. Malaysia ..	8·4 (4 sp.)	21·2 (4 sp.)	8·1 (4 sp.)	..	25	**75**	25	25	..	..	..
Cont. of Asia—											
E. Peninsula ..	9·5 (8 sp.)	20·4 (9 sp.)	8·1 (10 sp.)	30	20	**80**	50	40	..	..	..
W. Peninsula ..	8·8 (4 sp.)	20·5 (4 sp)	7·5 (3 sp.)	33	33	**67**	**67**	33	33	..	..
Ceylon	6 (2 sp.)	12 (2 sp)	6 (2 sp.)	..	..	..	..	100	..	..	..
PAYENA											
West Malaysia, Cont. of Asia (E. Penins.) (no difference)	7·8 (18 sp.)	15·7 (20 sp.)	7·8 (19 sp.)	..	..	**100**	16	16	..	..	..
GANUA											
West Malaysia, 1 species in Moluccas (no difference)	8·1 (8 sp)	16·8 (8 sp)	7·7 (9 sp.)	11?	22	**77**	**44**	**44**	..	..	..
BURCKELLA											
Moluccas, N. Guinea, Polynesia (no difference) ..	7·6 (7 sp)	16 (*6 sp.)	4·6 (8 sp.)	..	..	..	..	25	**63**	**63**	13

* *Note:*—Including *B. Thurstonii* (*see* note above), the A. average (of 7 sp.) would be 21.

It appears, I think, especially from the percentage data, that there is a tendency to be traced to reduce the number of carpels as the distance from the centre of dispersion is greater, both to the West (India, Ceylon) and the East (Polynesia). That this reduction is more distinct in the East may readily be ascribed to the preponderant insular character of those parts. In the other whorls, there is no correlation, possibly partly due to an eventual tendency to raise the number of petals and stamens *e.g.* by what has sometimes been called a reduplication ("dédoublement").

The above facts have been combined with my general ideas on the dispersion of the whole group in a tentative "genealogical branch" (Pl. 6) which may speak for itself, but concerning which I must state that, of course, complicated processes as the phylogeny of a group of plants can never be symbolized in a thoroughly satisfactory way on a sheet of paper; furthermore I have to emphasize that the "branches" are not meant to be "solid", but should be imagined as sponge-like tissues of extremely complicated structure. For the rest, I am quite aware of the very problematic value of such considerations and ideas.

A description and analysis of the new species may follow here:

Madhuca Ridleyi (Sect. *Dasyaulus*), nova species, Pl. 7— Arbor mediocris, ramuli crassi; internodiis brevibus bulboso-inflatis, 1.5–2 cm. longis et latis rugosis; folia ad eorum apices dense conferta; stipulæ deciduæ 0.3–1.2 cm. longæ pubescentes; folia coriacea glabra, obovata vel oblongo-obovata, 14–25 cm. longa, 5–10.5 cm. lata, basi in petiolum glabrum 1.5–3.5 cm. longum, 0.2–0.3 cm. crassum attenuata, apice acuta vel subrotundata; costa media i.s. supra canaliculata, subtus valde prominens; nervi secundarii subtus prominentes, 18–25, angulo 60°–70° de costa adscendentes, recti, prope marginem curvati, diminuti, haud conjuncti, 0.7–1 cm. distantes; nervi tertiarii transversi, angulo circ. 120° de costa descendentes, subtus conspicui, reticulatione perminuta, interdum nervo brevi secundariis parallelo a costa media usque ad ⅓–½ adscendente; *inflorescentiæ* ex foliorum delapsorum axillis ortæ, nonnullæ ad ramulorum longorum rectorum apices dense confertæ, 15–25-floræ, pedicelli minute tomentosi, graciles, 2–2.5 cm. longi; alabastra acute ovoidea; *calyx* 1–1.3 cm. longus, sepala extus dense minute fulvo-ferrugineo-tomentosa, intus glabra, angula apicale circ. 90°, exteriora 1.25 cm. longa, 1 cm. lata, interiora 1.3 × 1.1 cm.; *corolla* in alabastris vix exserta (flores novellos tantum vidi) 1.1–1.2 cm. longa, extus glabra vel subglabra, intus glabra; petala 18 uniserialia dextrorsum tegentia 0.95–1 cm. longa, 0.4 cm. lata, margine plus minusve irregulariter minute denticulata; *stamina* glabra 36–37, plerumque uniserialia, interdum nonnulli serie imperfecta addita, 0.5–0.6 cm. longa, nova filamenta usque ad 0.2 cm. longa, antheræ 0.2–0.35 cm. longæ, 0.15 cm. latæ, apice

acumine acuto 0.075–0.15–0.25 cm. longo ornatæ; *ovarium* glabrum depressi-globosum extus paulo sulcatum, 18–21- loculatum; loculi 1-ovulati; stylus solidus in alabastro 0.9 cm. longo; *infrutescentiæ* ramulorum apicibus subumbellatim confertæ, pedicelli 2.5 cm. longi, 0.25–0.3 cm. crassi, apice vix dilatati; calyx persistens, sepala 1–1.8 cm. longa, extus tomentosa; *fructus* globosi, apice sæpe stylo 3 cm. longo persistente ornatus, dense ferrugineo-pubescentes, pericarpio crasso subduro; 4–6 semina oblonga, testa tenuis, extus nitida; cetera ignota.

Malay Peninsula: Pahang, Bukit Serdam, Raub, 1300 ft., on dry limestone rocks (HENDERSON 25055, flowers, on 6 Oct. 1931, *type specimen*)—Upper Perak, Gunong Runto, Lenggong, 500 ft., on limestone (HENDERSON 23834, fruits on 11 June, 1930).

A small but rather stout tree, both specimens known growing on limestone; bark pale, horizontally and longitudinally fissured; fruits rusty brown.

I have to thank Mr. K. GRIFFIOEN for his assistance in preparatory work for this paper, and my colleague, Dr. L. G. M. BAAS BECKING for kindly looking over the English.

Summary.

After some theoretical considerations on modern phylogenetical Taxonomy as a discipline, dealing with morphological as well as geographical evolution and newly influenced by Genetics, it is stated that next to Paleobotany two categories of data may be considered important for our ideas on Phylogeny, *viz.* the present distribution of species and that of features. This is illustrated by examples taken from the *Eumadhuceæ*, a group of East-Asiatic to Polynesian Sapotaceæ. It is shown that the former Sunda-land is the most probable place of origin of this group and that the species have migrated both westward (India, Ceylon, Indochina) and eastward (Polynesia). Evidence for this suggestion is found in the distribution and evolution of certain features, especially in the reduction of the number of carpels in both directions mentioned. The paper was stimulated by the discovery of a new *Madhuca*-species, *M. Ridleyi*, from British Malaya, the gynæceum of which shows the highest number of carpels known in the whole group. A description of this species is added.

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Explanation of Plates 3-7.

Plate 3

Present Distribution of the Eumadhuceæ.

Well known species only; numbers between brackets under genera indicate total number of species, in the other columns they indicate the number of endemic species in the region concerned; however, it must be borne in mind that amongst these are a number of new and more recent species.

Plate 4

Areas of *Madhuca* (M), *Payena* (P), *Ganua* (G) and *Burckella* (B) and total number of species (*Eumadhuceæ*) in the separate regions.

Plate 5

Probable lines of migration.

Plate 6

Probable phylogeny of *Eumadhuceæ*.

Plate 7

MADHUCA RIDLEYI, n. sp.—a. branch with leaves; b. shoot with inflorescences; c. id. with fruits; (d) flowerbuds; e. outer sepal, in- and outside; f. id. inner sepal; g. corolla inside; h. petals; k. stamens; m. pistillum; n. ovary, cross-section—after HENDERSON 25055, except c. which is taken from HENDERSON 23834.

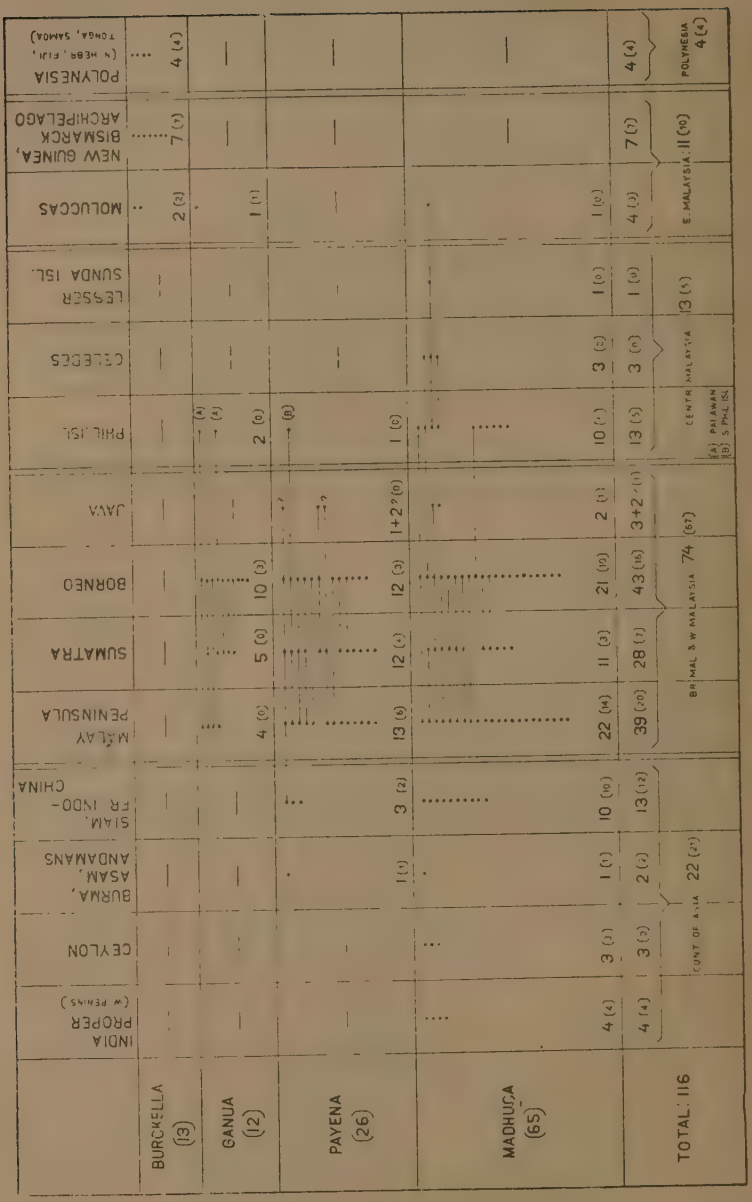
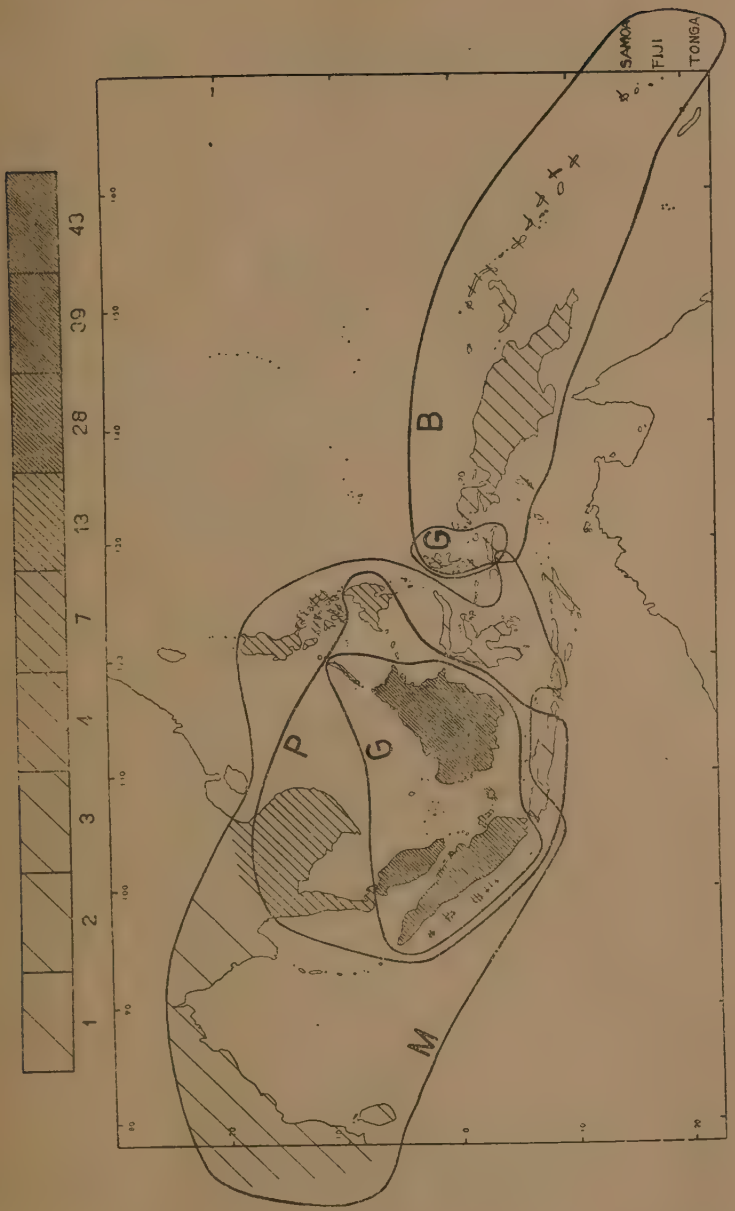


Plate 3 *Gardens Bulletin, S.S.*


SAMOA
FIJI
TONGA
B
G
P
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1
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3
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13
28
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43

Plate 5 *Gardens Bulletin, S.S.*

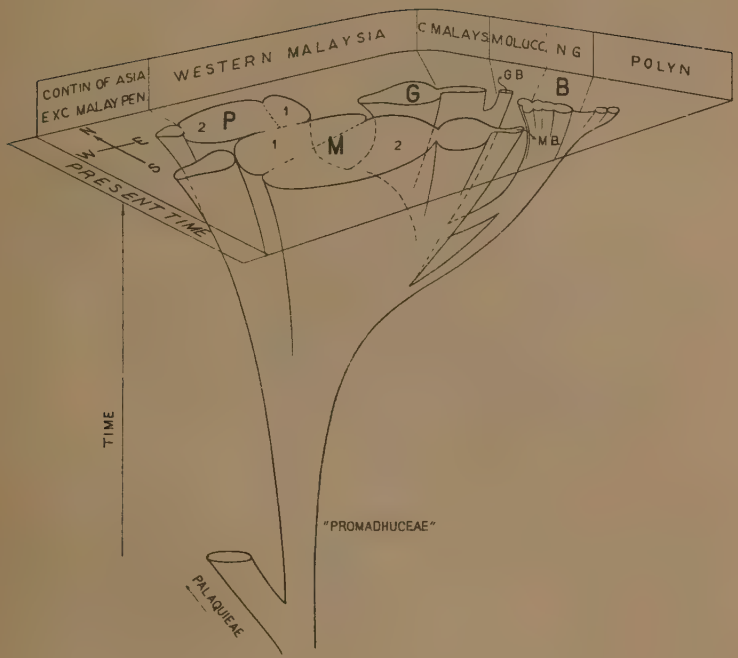
CONTIN OF ASIA
EXC MALAY PEN
WESTERN MALAYSIA
C MALAYS
MOLUCC.
N G
POLYN
G
GB
B
P
2
1
1
M
2
MB
PRESENT TIME
TIME
"PROMADHUCEAE"
PALAQUIEAE

Plate 7 *Garden's Bulletin, S.S.*

CHONEMORPHA MACROPHYLLA AND ALLIED SPECIES.

C. X. Furtado,
Botanic Gardens, Singapore.

Introduction.

Although *Chonemorpha macrophylla* G. Don is the type of the genus as currently interpreted, it is a species whose limits are not yet clearly defined, with the result that more than one species are included under that specific name, and this holds good even after the exclusion of the Philippine and Javanese material that was previously referred here. It is true that Ridley, acting on Stapf's suggestions on this matter, had (in *Agric. Bull. Straits & Fed. Malay States* X, 1911, pp. 146-148) created two new specific epithets, *C. penangensis* and *C. Rheedei*, hoping to straighten out the matter. But, as he did not bring out fully the chief characters that distinguish the three species, his paper did not succeed in making matters much clearer, and moreover his paper with Stapf's suggestions being published in a periodical of purely agricultural and local interest, failed to attract the attention of horticulturists and systematists even to the fact that *C. macrophylla* as then interpreted was being regarded as a mixed species. It is not surprising therefore that the two *Supplements* to *Index Kewensis* for 1911-15 and 1916-20, published respectively in 1921 and 1926, were issued without including Ridley's two new species, their inclusion not appearing until 1929 when the *Supplement* for 1921-25 was issued and when presumably the compilers' attention was drawn to Ridley's paper through a reference made to it in Ridley's *Flora II*, 1923.

In the hope, therefore, that the circumscription of *C. macrophylla* G. Don may become clear, and that the separation of the species usually confused with it may be easier, I have prepared the *Key* and the *Enumeration* given below. This paper not being a complete revision of the genus, I limit myself to giving only those synonyms and references which I consider may be useful to interpret the species correctly. I have also described a new species *C. assamensis*, based on a specimen from Assam.

The species are so variable as regards the hairiness and size of the leaves that it is not easy to distinguish them on that character. The general outline of the leaves, the comparative size of the corolla and the hairiness, size and shape of the calyx are more stable characters and so advantage is taken of them in framing the key. The hairiness of the pistil is apparently a useful character in separating these species, and may form an important basis in subdividing such polymorphous species as

C. macrophylla and *C. mollis;* but the material at my disposal was so meagre in flowers that I did not feel myself justified to detach flowers from the authentic specimens for the purpose of dissection.

From the enumeration given below it will be evident that the success of my inquiry into the various species commonly referred to *C. macrophylla* is due principally to the rich material preserved in the herbarium of the Royal Botanic Gardens, Calcutta. My thanks are therefore due to the Director of that institution for the loan of the specimens.

Key to the Species.

A Leaves of the flowering shoots elliptic to obovate, usually more narrowed in the lower half than in the upper; base rounded, obtuse or slightly cordate. Calyx glabrescent or distinctly hairy, urceolulate or companulate or crateriform; lobes triangular.

a: Calyx distinctly hairy or velvety, about 10–12 mm. long, slightly contracted at apex; lobes triangular, about ½ the total length of the calyx. Corolla tube 3–3.5 cm. long; limb 5–6.5 cm. across.

1. *C. penangensis.*

aa: Calyx glabrous or glabrescent, not contracted at apex;

b: Calyx glabrescent, 9–12 mm. long, campanulate; lobes about ⅓ the length of the calyx. Corolla tube 3–4.5 cm. long, contraction towards the base begins at the mouth of the calyx; limb 7–9 cm. across.

2. *C. macrophylla.*

bb: Calyx 4–5 mm. long, crateriform, glabrous; lobes about ½ the length of the calyx. Corolla tube 3–4.5 cm. long, contraction towards the base begins much above the mouth of the calyx; limb 7–8 cm. across.

3. *C. assamensis.*

AA Leaves of the flowering shoots ovate, oval elliptic-oblong, or almost orbicular, usually more narrowed in the upper half than in the lower; base rounded, cordate. Calyx glabrescent, campanulate; lobes triangular or ovate.

a: Calyx 10–13 mm. long; lobes ⅓ the length of calyx, triangular. Corolla tube 2–2.5 cm. long; limb 6–7 cm. across.

4. *C. mollis.*

aa: Calyx 7–10 mm. long; lobes ovate, gradually and arcuately narrowed towards the apex, overlapping at base, ½–⅔ the length of calyx. Corolla tube 2–2.5 cm. long; limb 7–9 cm. across.

5. *C. fragrans.*

Enumeration.

1. C. assamensis Furtado **spec. nov.**

A *C. macrophylla* G. Don, cui affinis, calycibus glaberrimis brevioribus, cupuliformibus; corollarum tubo supra (haud ad) calycum orificium dilatato; hæc species facile distinguenda.

A *C. fragrante* Alston calycum lobis trianglaribus, ramulorum foliis floriferorum obovatis distat.

INDIA: *Assam*, loc. incert (collected by a native collector under the supervision of G. Mann, in May 1893. Holotype in the Calcutta Herbarium).

2. Chonemorpha fragrans (Moon) Alston in Ann. Roy. Bot. Gard. Perad. XI (1929) 203 excl. syn., et in Trimen Fl. Ceyl. VI (1931) 192 p.p.

Echites fragrans Moon Cat. (1821) 20. Type.

C. Rheedei Ridl. in Agric. Bull. S. & F.M.S. X (1911) 146. *Syn. nov.*

C. macrophylla G. Don *sensu* Thwaites, Enum. (1864) 194; Hook. f., Fl. Brit. Ind. III (1882) 661 p.p. ; Trim., Fl. Ceyl. III (1895) 138 quoad specimina zeylanica; Cooke, Fl. Pres. Bombay II (1904) 139 quoad descriptionem et specimina citata; Gamble, Fl. Pres. Madras V (1923) 818 quoad specimina Indiæ australis. *Syn. nov.*

Belutta-Kaka-Kodi Rheede, Hort. Malab. IX (1689) p. 7, tt. 5 & 6. (Type of *E. fragrans* Moon).

CEYLON: loc. incert. (Thwaites, C.P. 2467 in Calcutta herb).

CULTIVATED SPECIMENS: *Singapore:* Botanic Gardens (Ridley, in 1911, holotype of *C. Rheedei*).

3. Chonemorpha macrophylla [Roxb.] G. Don, Gen. Syst. Dichl. Pt. IV (1838) 76; DC., Prodr. VIII (1844) 430, p.p.; Miq., Fl. Ind. Bot. II (1856 444 p.p; Thwaites, Enum. (1864) 194 p.p.; Hook., f., Fl. Brit. Ind. III (1882) 661 p.p.; Trim., Fl. Ceyl. III (1895) 138 p.p. Hook.f. Bot. Mag. (1896) t. 7492. Gamble in King, Mat. Fl. Mal. Pen. IV (1907) 693 p.p.; Ridley in Journ. Roy. Asiat. Soc. Str. Br. 57 (1910) 68.

C. macrophylla var. *grandis* A.DC., Prodr. VIII (1844) 450. *Syn. nov.*

C. penangensis Ridl. in Agric. Bull. S. & F.M.S. X (1911) 147 quoad specimina perakensia, et Fl. Mal. Pen. II (1923) 360 p.p. *Syn. nov.*

Echites macrophylla Roxb. sp. nov., Hort. Beng. (1814) 20, nom. nud., et Fl. Ind. II (1824) 13 excl. syn. *Type.* [non *E. macrophylla* H.B.K., Nov. Gen. et. Spec. III (1819) 219].

E. grandis Wall. Cat 1658, nom. nud.

E. latifolia Wall. Cat. no. 1657 E, nom. nud.

INDIA: *N. W. Himalaya,* Dehra Dun (Mackinnon in Aug. 1897). *W. Duars,* Buxa (Gamble, 7698). *Prov. Incert.,* Teendaria (Gamble, 3223 B & C); loc. incert. (Falconer). *Assam* and *Sikkim:* Sillet (Wall. Cat. 1657A); Kom (Wall. Cat. 1658); Kumaon (leg.?, in 1871); Goyalpara (Wall. Cat. 1657E); Slik (Rebu, 873).

BURMA *Shan States,* loc. incert. (Allen, 2); Lashio alt 2,600 ft. (Lace, 5838).

ANDAMANS: (Prain's coll., 57; Parkinson, 619).

MALAY PENINSULA: *Perak,* Temengo (Ridley, 14271); Larut, alt. 300–500 ft. (Kunstler, 3636); Gopeng, alt. 300–500 ft. (Kunstler, 6,000).

CULTIVATED SPECIMENS: INDIA, Botanic Gardens, *Calcutta* (Wallich, 1657B; Lane, 11,270). MALAY PENINSULA: *Singapore,* Botanic Gardens (Furtado, Nov. 15, 1935). *Selangor,* Kuala Lumpur in Public Gardens (Nov. 27, 1932).

With the exception of those from the Malay Peninsula, all specimens cited above are from the Calcutta Herbarium. The species is variable as regards the breadth and glabrescence of the calyx.

4. Chonemorpha mollis Miq., Fl. Ind. Bot. II (1856) 444. *stat. nov.*

C. macrophylla G. Don *sensu* Vidal, Cat. Pl. Prov. Manila (1880) 36; Hook. f., Fl. Brit. Ind. III (1882) 661 p.p; Koorders, Exkursionsfl. Jav. III (1912) 77; Heyne, Nutt. Plant. Nederl. Ind. IV (1917) 85, et 2nd Ed. II (1927) 1291. *Syn. nov.*

C. Blancoi Merr., Spec. Blancoanæ (1918) 312, et Enum. Philipp. Pl. III (1923) 335. *Syn. nov.*

C. elliptica Merr. & Rolfe in Philpp. Journ. Sci. III (1908) 121. *Syn. nov.*

Tabernæmontana elliptica Blanco sp. nov. Fl. Filip. (1837) 115 (non *T. elliptica* Thunb., Fl. Jap. 1784, p. 111). *Syn. nov.*

JAVA. (Horsfield, duplicate of the Type, in Calcutta herb.).

CELEBES: Bonto Parang (Bünnemeijer, 10572).

PHILIPPINES: *Luzon,* Borhoso (Ahern, 1141; Ramos, 1065). *Palawan,* Taytay (Merrill, 9249).

This species, like *C. macrophylla,* is very variable as regards the pubescence and the size of leaves and calyces. A further inquiry into the hairiness of the pistil and the corolla tube may be desirable to understand the exact significance of the several variations.

5. Chonemorpha penangensis Ridley in Agric. Bull. S. & F.M.S. X (1911) 147 excl. specimina perakensia, et Fl. Malay Pen. II (1923) 360 p.p.

C. macrophylla G. Don *sensu* Hook. f., Fl. Brit. Ind. III (1882) 661 quoad specimina malaccensia; Gamble in King, Materials IV (1907) 693 p.p.

Malay Peninsula: *Penang,* Balek Pulau (Ridley, 9441); Wang Seraya, alt. 500 feet (Curtis, 832); Ayer Etam (Haniff, in April 1916, vern. name: Gĕrip Merah), *Malacca,* Brisu (Derry, 543, vern. name: Akar Gĕrip-Gĕrip Merah.; loc. incert (Maingay 1074 = Kew n. 1837, in Calcutta herb.). *Negri Sembilan,* Tampin Hill (Burkill, 556). *Selangor,* Kepong (Symington, 20148; Pawanche, 14673, vern. name Akar Gĕrit Tembaga.).

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